E09792

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EDITOR'S PREFACE

This simple and very practical manual deals with the building of model yachts and explains how to design, draw, and develop the hull, and three approved methods of hull-building. It gives explicit instructions on the building of a model 10-rater, and also of one of the famous clippers, the latter being a popular showcase model. Sailing boats occupy about two-thirds of the book, the remaining space being devoted to the building of a model motor-boat complete with engine, boiler, oil furnace and special boiler-feed arrangement.

The Editor is happy in acknowledging the authorship of the larger part of this volume. Except for the first two chapters this book is a reproduction of articles contributed to a weekly journal by Mr. Edward W. Hobbs, A.I.N.A., M.J.I.E., Vickers Gold Medallist.

Readers may also be referred to a book by Mr. Hobbs in "Cassell's Model Series," namely "Model Sailing Boats" (6s. net), which deals in complete detail with all the various types, designing, building, fitting-out, rating, riggings, etc. etc., and is embellished with no less than 352 illustrations, the index containing about 750 items.

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BUILDING MODEL YACHTS

CHAPTER I

The Hull: Method of Design

System of Hull Construction.—There are four principal systems employed in the construction of the hulls of model boats, and in addition there are modifications such as, for example, the use of metal or paper in place of wood, or construction of part metal and part wood. Quite successful hulls have been made from strips of paper laid over a mould and stuck together with varnish. Another way is to beat the hull to shape from thin sheet metal, while a vulcanite hull can be made by building up the plastic material on a plaster-of-paris mould and encasing it in plaster; but the result is a hull on the heavy side, and one that is liable to distortion and easy fracture.

The systems particularly referred to are: cutting the model from the solid block, which may be termed the "solid block" method; the "bread-and-butter" system, in which the model is cut from a series of horizontally imposed boards; "plank" building, in which the outer skin of the boat consists of a number of planks either secured to ribs as in the case of full-size ships, or built upon a mould which is afterwards removed. These methods are dealt with in detail in succeeding chapters.

Methods of Design.—It is useless attempting to make a model boat hull successfully unless the meaning and use of the various construction lines are fully understood, for which purpose the following few notes are given.

The primary difficulty is to visualise the form of the hull from the drawings, and to appreciate the effect of an alteration of one section and its bearing on the other "lines." For the actual work of building the hull only a few "lines" are essential, but in the actual designing many lines are needed, to get a fair form.

Commence by studying the load-water-line (L.W.L.). This line represents the shape of a horizontal plane passing through the hull at the same level as that of the water in which the boat is floating. The hull is always drawn as if it were floating quite level and in stagnant water. Other water-lines are shown on drawings, and these are horizontal water-lines, parallel to the load-water-line (L.W.L.). The shapes of these water-planes are the shape that the water would take if the hull were floating in water at the depths marked, or, in other words, they would indicate the shape of the top of a hole in a block of ice if the water were to be frozen with the hull in it and subsequently lifted out. In designing the hull form other water-plane forms are sometimes drawn, as if the boat were sailing at an angle. The profile of the boat, or its outline as shown on the sheer plan, is the shape of the boat on a vertical plane through the fore-and-aft centre-line.

The deck-line (D.L.) is the horizontal shape of the deck, shown on the half-breadth plan, and the " sheer " or curved shape of the hull side where the deck meets it. The half-breadth plan shows only one-half of the hull from the centre line, as, of course, both sides of the hull are or should be alike. For the same reason the body-plan only shows the shape of one-half of the hull. The body-plan lines correspond with those similarly marked on the sheer and half-breadth plans. The curved or section lines are cross-sections at right angles to the centre line of the boat, and perpendicular through it. They represent the shape of the hull as it would appear if it were to be sawn asunder on any one of those sections.

The body-plan is generally the most useful to work to when building the hull. The buttock lines are the shape of a longitudinal and perpendicular plane that is parallel with the longitudinal centre line of the hull, but is taken some distance out from the centre. The buttock lines are also shown on the body-plan, and wherever a buttock line cuts a water-line on the sheer and half-breadth plans it must correspond with those positions on the body-plan, otherwise the hull form will not be fair.

CHAPTER II

Drawing and Developing the Hull

THE first step necessary in designing a model is to make drawings to show the "sheer-plan" (Fig. 1), "half-breadth-plan" (Fig. 2), and "body-plan" (Fig. 3). Stretch the drawing-paper on a drawing-board, and draw a vertical line up the centre, and erect the perpendiculars A and B (Figs. 1 and 2). The horizontal centre-line A B may then be drawn, and with this line as a datum, the base-line of the body-plan and the base-line of the sheer-plan are drawn. On the centre-line of the half-breadth plan, locate the points 1, 2, 3, 4, 5, 6, and 7 at equal distances apart, and draw vertical lines from each; vertical sections are drawn on the sheer-plan at the same time to correspond, the sheer-plan being, of course, exactly above the half-breadth plan. An intermediate line, numbered 1½, is inserted between sections 1 and 2 to assist in fairing (or "blending") the stern-lines. Section-lines 3 and 5 may be drawn through to the top, thus giving the side-lines for the body-plan. The varying heights of the deck-line should next be gauged above the base-line of the sheer-plan, the lowest point of the deck being at section-line 4.

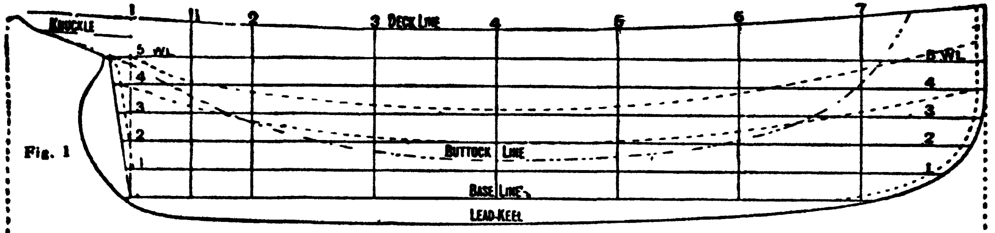


Fig. 1

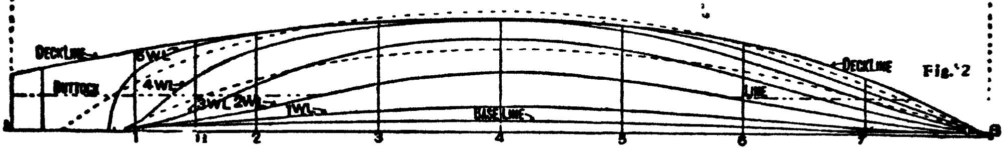


Fig. 2

Fig. 1.—Sheer-plan of Model Yacht. Fig 2.—Half-breadth Plan of Model Yacht

Now draw the deck-line lightly but distinctly, and transfer the heights to the body-plan. This can best be done by using a slip of paper about 9 in. long and ½ in. wide; many such slips will be required before the design is complete. For great accuracy, however, the distances should be transferred by means of the dividers. Vertical sections 1, 1½, 2, 3 and 4 can be marked on one side of the slip, the fore heights being copied on to the other. Transfer the points to the body-plan, and draw horizontal lines through each spot to the side-lines, No. 4 (the midship one) being drawn right across. On each side of the centre-line allow ⅛ in. to equal half the width of the stem and stern-posts for the transom, and draw the vertical lines as shown on the plan.

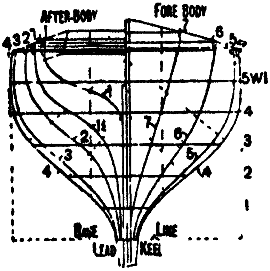


Fig. 3.—Body-plan of Model Yacht

To draw the deck-line on the half-breadth plan, measure the centre distances at each section, and set off four times that measurement, the greatest half-breadth of the deck (No. 4) being kept $\frac{1}{16}$ in. less than half the width of the boat. Set off the half-width of the stern as before, and the length ¼ in. behind (nautical, abaft) the fore perpendicular, after which the deck-line may be drawn exactly as in the case of the sheer-plan. The half-breadths of each section may now be transferred from the centre-line by the aid of another slip of paper; the same distances should be set off on the horizontal lines of the body-plan, care being taken that each half-breadth is on its own line. The intersecting curves, shown in Fig. 2, should be drawn by the aid of the wood curves.

Water-lines 1, 2, 3, 4, and 5 should next be set up on sheer-plan, these being drawn 1 in. apart. Measure with another slip the distances of the front of the stem before No. 7 vertical section on the base-line and water-lines 1, 2, and 3; the line will meet the perpendicular at No. 4 water-line. Set these off on the full-size plan, but do not draw the line until the lower edge of the lead keel is approximately shown.

The depths of the keel-line below the base-line having been set down, from No. 1½ to 7 inclusive, draw the line lightly by the aid of batten and weights; turn the board round and make the stern-line, the stem-line being also drawn through the spots whilst the board is in its fresh position. The inside line is drawn from the deck to the base-line ¼ in. in all the way. In putting in the stern, the knuckle-line is set ⅝ in. below the deck-line and parallel to it, and 1 in. in from the aft perpendicular. Draw the sloping line from deck to knuckle, gauge on No. 5 water-line a point ⅞ in. abaft No. 1 section, and draw through it the counter-line from the extremity of the knuckle, the line in question being slightly curved.

To set the rake of stern-post, measure the distance from No. 1 section to where the aft side of the post cuts No. 4 water-line, draw a straight line up from the intersection of No. 1 with the base-line, and another one ¼ in. within and parallel to it to represent the fore-side of the stern-post. Square down on to the half-breadth plan the aft extremity of the knuckle, and, at the centre, the points where the base-line and water-lines terminate on the fore-side of stern-post. In the same manner square down at the fore end, showing where the said lines meet the after-side of stem, represented by the inside line.

The outline of the stem and the rake of the stern-post may be modified if desired, but any alteration on the sheer-plan will, of course, affect the half-breadth plan. If the boat is intended for racing purposes, the stern-post may be advantageously set at right angles to the load-water-line; if not, the appearance will be improved by setting it otherwise. After deciding this matter, set off the half-breadth at midship section (⅜ in.), and allow half the thickness of stem and stern-post at each end. Draw the base-line on the half-breadth plan, curved so as to give the keel a firmer hold. By the aid of another slip transfer the half-breadths of base-line to the body-plan, setting off Nos. 4, 5, 6, and 7 to the right of centre-line, and Nos. 4, 3, 2, 1½, and 1 to the left.

To set out the midship section, commence by making a pencil line on the centre-line of body-plan ⅜ in. above base-line, and on each of the vertical side-lines a similar mark midway between water-lines 3 and 4. Draw straight lines from the first point to each of the others, the "rise-lines" of the section being thus obtained; and by running a horizontal line across the body-plan, midway between water-lines 1 and 2, or 1½ in. above base, and another ¼ in. below No. 3 water-line, or 2¾ in. above base, the points at which the section-line begins to curve will be found. Make points on the vertical side-lines halfway between Nos. 4 and 5 to represent the point where the midship section meets the side-lines.

Use French curves (of the "Ship" pattern) to draw the lower part from the base to where it intersects the rise-line. The upper part has now to be drawn from the deck downwards, and this may be done with the board turned round or by the draughtsman shifting his own position so that he can see the spot where the section meets the rise-line. Finish one section before attempting the second, carefully testing the half-breadths on each water-line to see that they correspond.

To draw the stern-line on the body-plan, take its extreme breadth from the half-breadth plan, and its height trom the sheer-plan; prick off these two points on the centre-line and draw a line to join them, representing the port side of the stern at the deck level, parallel to which may be drawn a line representing the extremity of the counter.

Set off the buttock-line on the half-breadth plan, and extend it from the after perpendicular until it cuts the deck-line forward. The same line must also be shown on the body-plan, vertical lines being struck from base-line to deck, intersecting the midship section between water-lines 1 and 2. To show the buttock-line in elevation on the sheer-plan, measure on the illustration the height above the base-line where the buttock-line crosses each section.

Test with the dividers whether the height above base for the midship one corresponds with that shown on the body-plan; if not, the height on sheer-plan must be made to agree. Square up from the half-breadth plan to the sheer-plan the point where the buttock-line meets the deck-line forward. Draw in the buttock-line in elevation.

Sketch lightly in freehand on the body-plan the form of each section. Commence at the proper point on the deck-line, pass through that on the buttock-line, and bring each down to its own place on the base. This done, transfer from body-plan to half-breadth plan the approximate position of each of the sections. Use slips for this purpose, applying one first to water-line 5, then to 4, 3, 2, and 1. Then, using the T-square, transfer from sheer-plan to half-breadth plan the points where the buttock-line is crossed by water-lines 2, 3, 4, and 5.

Water-line 5 can be drawn forward, the part aft of that section being then drawn by the aid of curves.

CHAPTER III

Carving the Hull from the Solid

BEFORE commencing the construction of a boat that is to be carved from the solid, it is necessary to obtain a piece of wood of suitable size and shape out of which to make it. It is an essential that the wood be free from cracks and knots, quite dry, and capable of being easily worked. The wood used may be either yellow pine, white fir, or other soft, straight-grained material.

Having cut a block to the right dimensions, rule a line lengthways right round it exactly down its centre, passing down the middle of the deck, keel and bow. Then rule a line on each side of the keel line to represent the thickness of the keel. The block is now ready to be cut into shape.

In cutting the block to shape, begin by roughly chopping out the interior, leaving the sides about ½ in. thick. To do this, bore holes with a 1-in. centre-bit, close to one another all over the part to be cut out, and then chisel away the intervening wood. Then turn the block upside down, and shape the outside. A set of templates, made to correspond with the body-plan, will be required, and as the work of cutting proceeds these should be frequently used in their correct respective positions. With a chisel chop out the keel, except at the widest part, where there is no keel at all, to the depth of ½ in. The position of the keel is now so marked that it cannot be obliterated. The sides should be shaped first with a chisel and then with a spokeshave or plane, and they should curve with a continual graceful bend. When nearly reduced to the right size, see that both of the sides have the same shape. If satisfactory, shoot the top of the hull and the keel quite true with a trying plane, and cut the bow and the part of the keel where the rudder is placed quite straight with a chisel. The flat part of the hull, near the stern, can be finished off with a small iron smoothing plane; its upper part should be slightly thicker than the lower part.

The interior should now be finished off. It should have a curve corresponding to that of the sides, and the wood must be cut out in small pieces until the sides are sufficiently thin.

The wooden keel is a strip of wood whose edges have been shot quite true, and it is fixed to the hull by three or four long screws. It must be wider at the end which is placed at the stern than at that which is placed at the bows; care must be taken that it does not lean to one side.

When the hull has been finished, the deck may be fitted to the hull with nails or screws, its edge being allowed to overlap slightly. The deck is a board thicker in the middle than at the sides, so that the water which washes over it will run off more easily, and it is strengthened underneath by braces of wood fastened across it. Before fastening down, all mast holes and hatchways must be cut in it, and, if wished, it can be ruled with lines to represent the joints between the deck boards, the lines being afterwards slightly indented.

Before the metal keel is fixed, a hole must be bored near the stern for the reception of the upper part of the rudder. A small hole should first be made through the deck and hull, and then a larger hole down this one with a bit of suitable size. A piece of brass tube which will fit tightly into this hole should then be pressed in, and the ends filed off flush with the wood.

A lead keel, thicker and wider at the end which is placed at the stern, is then to be fitted on to the wooden keel by screws passing through holes bored in it.

The hull must next be thoroughly glasspapered smooth all over, and the bulwarks, of ¼ in. walnut-wood, may then be fixed to the deck with nails or screws at such a distance from the edge that a ledge ¼ in. wide projects all round. A half-rounded strip of wood is then fastened round the outside of the hull slightly above the water-line, and is brought to a point at the bows. A thin piece of sheet copper is nailed across the bows from the bulwarks down to the metal keel, to prevent the wood from being damaged in case of collision.

CHAPTER IV

The "Bread-and-Butter" System of Hull Construction

FOR the "bread-and-butter" system of construction it will be convenient to use four planks, though more or fewer may be used according to inclination. The bows and stern may be made up with additional pieces as is requisite to obtain the "sheer" or upper curvature of the hull. Having prepared the four pieces they must be marked out, and to do this commence by drawing a longitudinal centre-line down the length of the planks. Then mark off at right angles the cross-section lines Nos. 1 to 16 (Figs. 4, 5, and 6), which represent the drawings for the hull of a model clipper. Now on the lower plank set off the shape of the water-plane as shown by the water-line marked w2. Mark the second plank in the same way, but to water-line w1. The third plank will be marked out to the shape of the load-water-line (L.W.L.), while the fourth or top plank will be marked out to correspond with the deck-line.

The planks may then be cut to shape with a band saw, if available, or by means of a keyhole saw or a frame saw. Take care to leave the pencil lines showing, and allow sufficient for cleaning up properly.

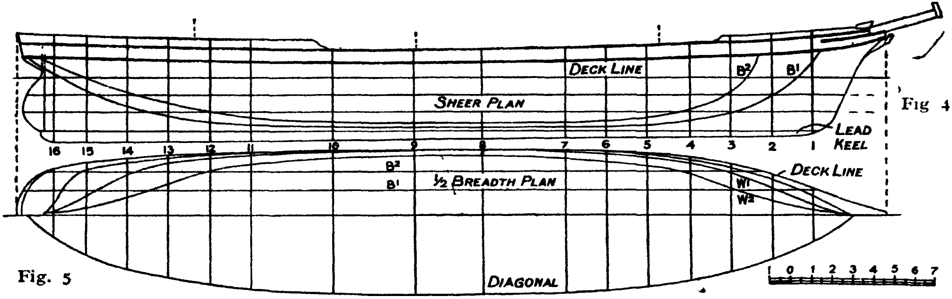


Fig 4

Fig. 5

Figs. 4, 5 and 6.—Method of Drawing Hull

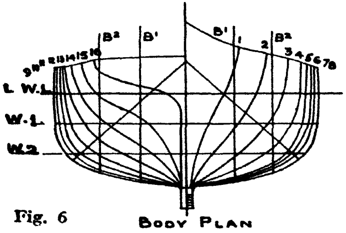


Fig. 6

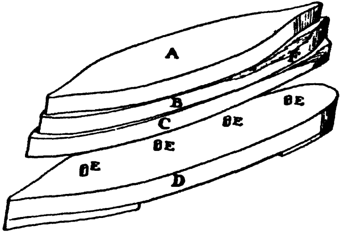


Fig. 7.—Preliminary Stage of Hull

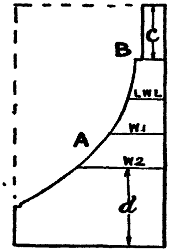


Fig. 8.—Templates

Now drill four equally spaced holes about $\frac{3}{8}$ in. in diameter and on the centre-lines, and fit dowel pins into them, so that all four planks are retained in their proper places with the centre-lines registering, and all the cross-section lines vertically above each other. The exterior of the hull may now be roughly shaped, but do not shape the bottom plank until later. It will be sufficient to remove the surplus wood from the "steps." The appearance of the work at this stage is given by Fig. 7, which shows the lower plank at A, intermediate planks B and C, upper plank D as if detached, and the dowel pins E in place. These dowels are made to fit into holes in C, while the steps are shown as roughly shaped at F.

A set of cardboard or thin wood templates or moulds must be made, and should be marked out as shown in Fig. 8. The cut-away part A is to agree with the outlines as given on the body-plan (Fig. 6), one mould to each section, sixteen in all. Only the shape of one-half, or one side, of the hull need be cut out on each mould, as it only needs reversing to be used for either side of the hull.

When cutting out these moulds it is desirable to mark the L.W.L. and water-lines W1 and W2, also the deck-line heights; cut out the corner from the deck-line level, as indicated at B. This will facilitate inspection and it also gives the correct level for the deck at each section, and settles the sheer-line without extra marking out. It is also convenient to have the dimensions at *c* and *d* uniform, as it will be found to save a lot of trouble and time to fix two blocks to the workbench, so that when the hull is laid on them and the moulds are standing vertically on the bench, the L.W.L. line marked on the mould will register with the L.W.L. line on the hull. When the shaping work is proceeding, all that need be done is to place the hull on the blocks and apply the mould to its appropriate section. Of course the hull will lie bottom upwards, and the sheer-line will be cut last, as otherwise the hull would not be true. Also the bench will need to be fairly flat.

These moulds may be used to check up the rough shaping as far as possible. When this is done the plank should be marked off to show the maximum amount of wood that can safely be cut from the inside or middle of the three upper layers. In doing this take care to leave at least ⅜ in. thickness everywhere, and also remember that it is only possible to cut to the smallest-size hole. That is, the top plank can be cut so that there is at least ⅜ in. thickness left at any part of the joint to the next plank, which means that the bottom of the upper plank must be so marked that when it has been cut to shape it will allow of at least a ⅜-in. wide joint being made to the next plank.

Mark them all in a similar manner, and then drill and fit a few small dowel pins, inclining them as far as possible to follow the shape of the hull. Cut out the middle portions, and glue and dowel the four layers together and clamp them up tightly. When doing this the flat bottom will be found very useful.

Leave the job to set thoroughly, and then the exterior can be finished in the usual way with chisels, gouges, plane and glasspaper. The interior can be scooped out at the same time, and should be made as neat a job as possible. Cut away all surplus wood, and thus reduce the weight as far as is feasible.

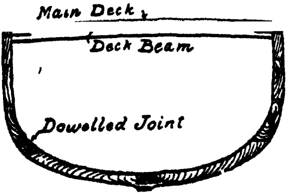


Fig. 9.—Diagram showing Deck Beams

Prepare a deck from $\frac{1}{8}$-in. pine, and carry this on small deck beams glued and pinned to the interior of the hull. These beams are to be $\frac{3}{8}$ in. deep, cut from hard wood $\frac{1}{4}$ in. thick, and cambered as shown in Fig. 9 and spaced 6 in. centre to centre. The edges of the deck should be neatly finished as a half-round beading, and should project $\frac{1}{16}$ in. beyond the hull sides; but do not fix the deck permanently at this stage. The upper or face side of the deck will be marked out to represent planking, but details of this will be given in a later article when dealing with the deck erections, etc.

Give the hull several light coats of undercoating paint, glasspapering between each coat, and at least one coat of good oil paint of any desired colour.

CHAPTER V

Plank Building

Of the many methods of model-boat construction none offer such attraction to the enthusiastic model builder as the system known as "plank building." This system consists in building the model in a similar manner to the full-size boat, by planking the hull with thin pine or mahogany planks secured in shape and position by bent or sawn ribs. The backbone or keel of the boat is first cut to shape, and the stem and stern cut and fitted in place. The ribs are bent and secured in place about 3 in. or so apart, and the planks afterwards cut, fitted, and secured in position.

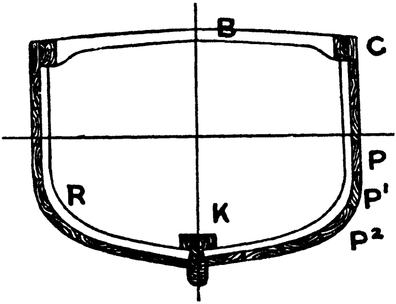


Fig. 10.—Section of Plank-built Boat

A cross-section of a typical plank-built boat is shown in Fig. 10, the backbone of the boat being the keel K. The ribs of American elm are bent to shape as shown at R, the planks and their modes of

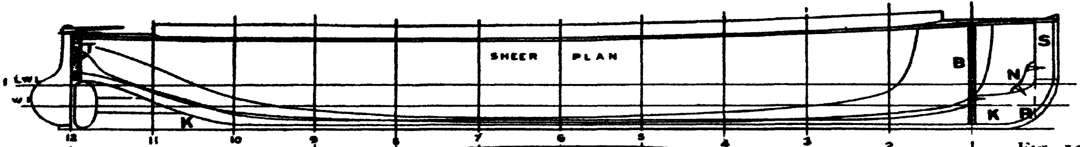


Fig. 12

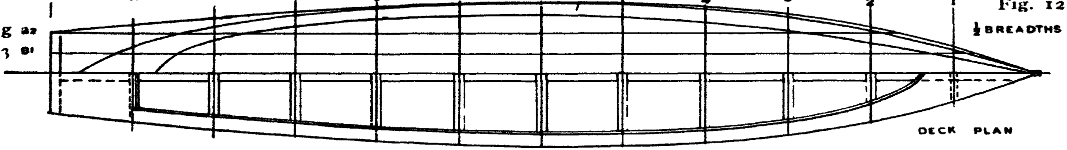


Fig 13

Fig. 14

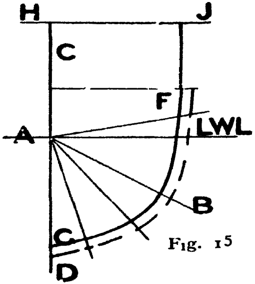


Fig. 15

Figs. 11 to 15.—Design for Plank-built Boat

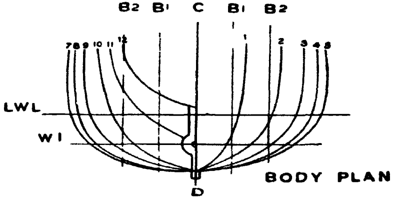


Fig. 11

fastening are shown at P, P^1, and P^2. It will be noted that the ribs R are secured to the keel K, and that this is rebated out to receive the inner plank or garboard strake. The gunwale strake G and deck beams B strengthen the upper work of the hull.

Such a model is usually lighter than the "dug-out" or "bread-and-butter" methods of hull construction, and although the system of plank building has been most extensively used for model sailing-yacht construction, the system can with advantage be applied to model power boats.

In this chapter the general principles of plank building will be indicated, and some methods that can be adopted. For the sake of convenience, the construction of a model open steam-launch hull will be detailed.

The same methods of hull construction are equally applicable to any model, either sailing or power, with but very slight modification. The easiest forms of hull for plank building are those with rounded or "easy" sections, and the design shown in Figs. 11, 12, 13, and 14 has been selected for this reason.

The Mould Plan.—Having obtained the design, the first process is to construct a "mould plan" (Fig. 15), by drawing a plan similar to the body plan (Fig. 11); but smaller by the thickness of the planking and the ribs. For small models up to 5 ft. in length the planks may safely be made $\frac{1}{8}$ in. thick, and the ribs, if bent, may be also $\frac{1}{8}$ in. thick; but if they are sawn they must be somewhat thicker, the amount depending on their shape and position. For ordinary work the bent ribs give excellent and satisfactory results, and it is this method of construction that will be detailed. The mould plan may readily be drawn from the body plan by constructing a diagram such as is shown in Fig. 15, the centre-line C D and the load-water-line (L.W.L.) being drawn exactly as on the body plan. The diagonal lines A B are then drawn, and corresponding diagonal lines must be marked on the body plan. The lengths from the centre A to the section line (as at B) are then marked off along the corresponding line on the mould plan, less the thickness of the rib and plank (in this case ¼ in.). The true section of the outside of the boat when planked is shown dotted in Fig. 15. and corresponds to the body plan. The mould section is shown by F G.

Each section is treated in a similar way. except the transom or end plank (section No. 12). which is only ⅛ in. (the thickness of the planks) smaller than the body plan and section No. 1, which is also solid, and consequently has only to be made ⅛ in. smaller than the body plan, as no ribs are fitted at section No. 1. the solid bulkhead being used instead.

Having marked off the shape of the moulds, draw a parallel line H J to form a base-line. at right angles to the centre-line C D, parallel to the L.W.L. and a convenient distance from the same, say 6 in., and connect the mould sections to this base-line with perpendiculars as at J F.

Transom.—The next matter is to cut the transom T (No. 12, see Fig. 12) from ⅜-in. mahogany or pine, and the bulkhead B (No. 1, Fig. 12) from similar material ¼ in. thick. At this stage the need of using only the very best and dry timber must be emphasised, as although the best selected stuff is expensive, such a small quantity is required that it proves most economical in the end. If possible use old dry wood that has been in stock in a good dry place for a year or two. In this class of model work shrinkage of the timber is most aggravating and objectionable, causing the seams to open and leak.

Moulds.—The moulds themselves may be cut from any rough material about ⅜ in. thick; but the centre-line C D, load-water-line (L.W.L.) and base-lines H J (Fig. 15) must be marked clearly and accurately on each mould. The curved sides should be cut to correspond, so that when all the moulds are cut to shape, according to the mould-plan drawing, and stood upright on the base H J, the L.W.L. lines will agree and make a straight line, as well as the centre-line; otherwise the boat cannot be true and fair.

These moulds are now to be mounted on a bar of timber about 3 in. by 2 in. in section, and planed up true, the moulds being screwed in place and the correct distance apart as shown on the sheer-plan (Fig. 12). The forward-sections (Nos. 2, 3, 4, 5, and

6) are screwed so that they are in front of the section lines, and the after-sections (Nos. 7, 8, 9, 10, and 11) are screwed in place so that the thickness of the mould is behind the section line, as shown in Fig. 16. B is the base bar, M a forward-section mould with the thickness in front of the section line 6, and N an after-section mould with the thickness behind the section line 7.

Having secured the moulds with screws as shown, take a batten about 3 ft. long and ¼ in. square, and lay it round the moulds, when it will be noted that if the batten is bent fairly easily, it will lie on the front edges of the forward-sections, and on the after edges of the after-sections. To complete the shaping of the moulds, these edges must be cut to a bevel to correspond with the shape of the boat as indicated by the batten, so that when the ribs are in place the planks will fit fairly and easily to them, and not lie on one edge only of the rib.

Keel.—The moulds may then be laid aside while the keel K (Fig. 12) is cut from ¾-in. thick mahogany. The shape and dimensions of this keel piece, of course, vary with various models, but the principle remains the same throughout. When this part has been cut to shape, cut a piece of the same material for the stem S, and a piece for the knee N. The stem S is then mortised into the keel K, and the knee N glued and screwed into place, making a good sound joint.

When the glue has set thoroughly hard, plane up the piece perfectly flat and true, and fit the transom by screwing it into the keel as shown. The bulkhead No. 1 is also screwed in place, and both these parts may ultimately be glued; but it is best to leave this until all the work on the keel has been completed and the ribs are ready to be fitted in place. The mould box must now be taken in hand, and an upright fixed at section No. 12, and arranged to act as a "fence" or stop for the transom to ensure its being in its correct position as shown. A similar upright is cut and fitted at the stem, and a packing block fitted for the head of the stem to rest on, another block for a similar reason being fitted for the transom to rest on. The dimensions for these parts can be obtained from the sheer-plan (Fig. 12) by drawing a line at the same distance from the L.W.L. as the line H J in Fig. 15. If the keel piece is now tried in place, it will be found that the moulds must be cut away in the centre to allow the keel to fit. So carefully cut out the centre portions of the moulds until the keel can fit into its proper place, when it will be found to project above the moulds by approximately ½ in.

Now with a pencil mark the positions of the moulds M on the keel K as shown at P (Fig. 17). These places indicate the bottom surface (as the mould stands) of the ribs, so mark off the width of the ribs (⅛ in. in this case), and cut away the keel to form a rebate R (Fig. 18) on each side ¼ in. wide, leaving ¼ in. of timber

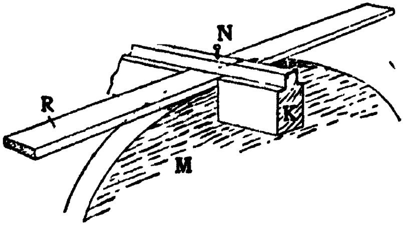


Fig. 22.—Fitting Rib in Position

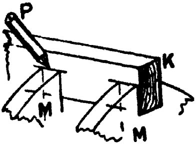


Fig. 17.—Marking-off Rebate in Keel

Fig. 16.—Arrangement of Moulds

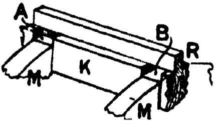


Fig. 18.—Preparing the Keel

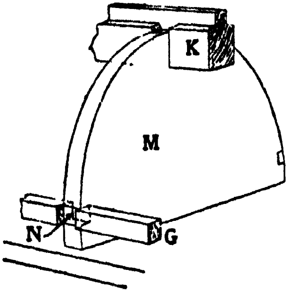


Fig. 20.—Fitting the Gunwales

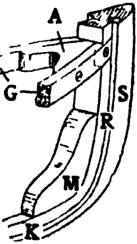


Fig. 21.—Fitting Gunwales to Stem

Fig. 19.—Photographic Reproduction of Backbone or Keel of Boat

remaining in the centre. This rebate should not be cut too deep at first, but only roughly to size, carrying it along the stem, as shown in Fig. 18 at R. If the vessel is to have a propeller shaft, the rebate at the stern should be little more than a groove.

Now, as in place of each mould it is necessary to fit a rib, a pocket or notch A (Fig. 18) must be cut to accommodate the rib and to provide a secure fixing. At the midship sections Nos. 4, 5, 6, 7, and 8 these pockets may be pierced right through the keel as at B (Fig. 18), thus allowing the rib to pass through the hole and making an unbroken rib from gunwale to gunwale, thus considerably strengthening the hull. This latter course can, however, only be adopted when the cross-sections are practically flat. Before the ribs can be actually fitted, it is best to secure the gunwales in place.

The reproduced photograph (Fig. 19) shows the keel piece with stem, transom, and bulkhead fitted in place.

Gunwales.—Two gunwales $\frac{3}{8}$ in. square and made from ash or oak must be fitted. This is accomplished by marking the sheer of the boat on each separate mould and cutting a notch $\frac{3}{8}$ in. wide and $\frac{1}{4}$ in. deep into the mould. When all the notches have been cut, a strip of the timber may be laid in place as shown at G (Fig. 20); but the gunwale itself must be cut away for a depth of $\frac{1}{8}$ in. for the reception of the rib. This notch is shown at N, and corresponds to the notches which have previously been cut in the keel; their object is to ensure that when the rib is fitted in place, the faces of the rebate in the keel and the outer ends of the gunwale shall all be smooth and uniform.

To secure the gunwale at the bow of the boat, it is necessary to check them into the stem S (Fig. 21), and secure the same with a small countersunk brass screw. To further strengthen the joint, an angle-piece of hardwood is cut and fitted in place as shown at A, the two gunwales being shown at G, the keel at K, the strengthening piece at M, and the rebate cut in the stem at R.

Ribs.—The next process is to fit the ribs in position, and this is accomplished by taking a sufficient number of pieces of American elm of suitable length and width, and steaming them. To accomplish this a domestic fish-kettle may be used; or, failing this, a large pot may be placed on the fire, and a small piece of wire netting placed near the top to keep the ribs out of the water, so that the timbers are in the steam.

After about half an hour's steaming the timbers will probably be sufficiently soft and pliable for use; but before attempting to bend them it should be seen that the ribs are really soft and pliable. When they are in this state, select a piece sufficiently long to suit the midship section, which in the case of the model being described is a very easy form. The rib R is first passed through the keel piece, if the same has been pierced in the manner already described, and a copper nail N (Fig. 22) driven partly through the same to prevent the rib from moving. It is then bent downwards equally on both sides until it lies smooth on the mould M. The ends of the rib may be secured, if occasion requires, with a piece of string, which may be tightened up with the aid of a miniature tourniquet. Two copper nails or brass screws are driven into the gunwales to keep the same in place.

Fig. 23 shows diagrammatically the position of the model at this stage. The keel is shown at K, the copper nail at N, the mould at M, the base bar at B, and the rib at R, the gunwale being shown at G. All the other ribs are fitted in similar manner, except that at the more forward and aft positions the rib must first be inserted into the pocket cut into the keel, and be screwed in place with small brass countersunk screws as shown in Fig. 24, where R is the rib, K the keel, and S the screws.

Sawn Ribs.—Those who prefer to build their model with sawn ribs will follow a somewhat different practice, and, instead of making all the moulds, it will only be necessary to fit two of them, one each at sections 3 and 9 respectively. This will be sufficient to keep the keel in place. A suitable piece of elm or oak, preferably with a curved grain, should be selected, and may be about ⅜ in. thick for a metre boat. Each section has then to be marked out on

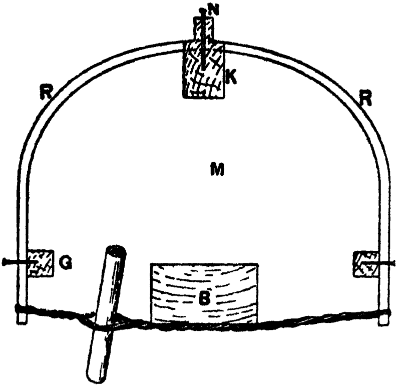


Fig. 23—Bending Rib in Position

the timber, and a rib sawn from the same somewhat after the fashion shown in Fig. 25 at R. It will be noticed that the rib is cut to form a knee for the reception of a screw which secures the same to the keel. At the upper end of the edge a notch at G is cut for the reception of the gunwale, and the rib is strengthened by making it project somewhat at that end as in the illustration. To keep the same in position, a temporary cross-bar of any rough stuff is fitted as shown at A. This will be secured by a brad to the

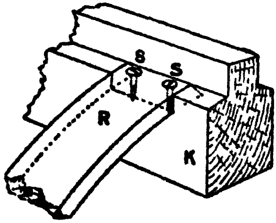


Fig. 24.—Securing Rib to Keel

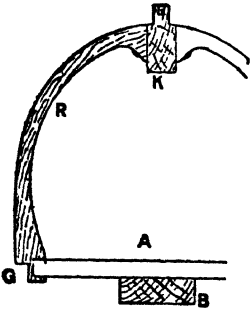


Fig. 25.—Sawn Rib

baseboard B. This method of construction has much to recommend it as being quick and simple; but, on the other hand, is somewhat heavier and not quite so strong as the method of using bent timbers.

Planking.—The planking of the model is carried out with either system in precisely the same manner, and this work may now be taken in hand. There are two methods of securing the planks to the ribs. The first is merely to fix them to the ribs with small brass screws; but this method is laborious, and requires great care to prevent the material splitting. By far the best plan is to adopt the practice of the shipyard, and use copper nails and rooves, which may be obtained from model supply houses. Copper nails are of two patterns. One type is circular in cross section, and the other is square and known as a rivet. The method of their use is as follows: The plain nail as shown in Fig. 26 is first driven right through the plank P and the rib R, and projects beyond the rib as at A. The head of the nail is then struck sharply with a light hammer, turning the point over as at B. This process is then repeated, but hitting the nail more closely to the rib, finally clinching it right over as shown at C. While these operations are being carried out, it is, of course, necessary to hold a heavy hammer against the head of the nail or the rib, as the case may be, otherwise the nail will come out again and not bend over.

Fig. 27 shows the method of using the copper rivet and roove. The rivet R is first driven through the plank and rib, and a roove W. which is a circular disc of copper somewhat like a washer, is put over the same. A heavy hammer is then held against the head of the rivet, and the point hammered up to form a head, and so clinch the washer firmly into the rib. To accomplish this nicely the portion of the nail projecting beyond the washer should not be more than twice its diameter, and any surplus should be cut off with a pair of cutting pliers. A light hammer will be found most suitable for this work, and once the right knack has been obtained, the process can be carried out with great rapidity.

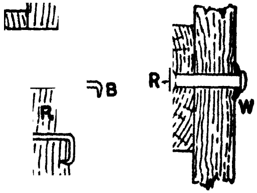


Fig. 27

Fig. 26

Figs. 26 and 27.—Methods of Fastening

Fig. 28 is a photograph of a model liner hull built up on a somewhat similar system to that described. This illustration is particularly useful as showing the general appearance at this stage of the work, the only difference being that in the illustration the moulds have been removed.

The chief requisites for the successful planking up of a model boat are accurate fitting and patience. The whole method is in reality a simple process, but one that is very difficult to describe in words, and some practice is necessary before really good results are obtained.

For the planks, secure some good dry pine or mahogany about ⅛ in. thick, a few inches longer than the model, to allow for the curvature. The boards may be cut up as required.

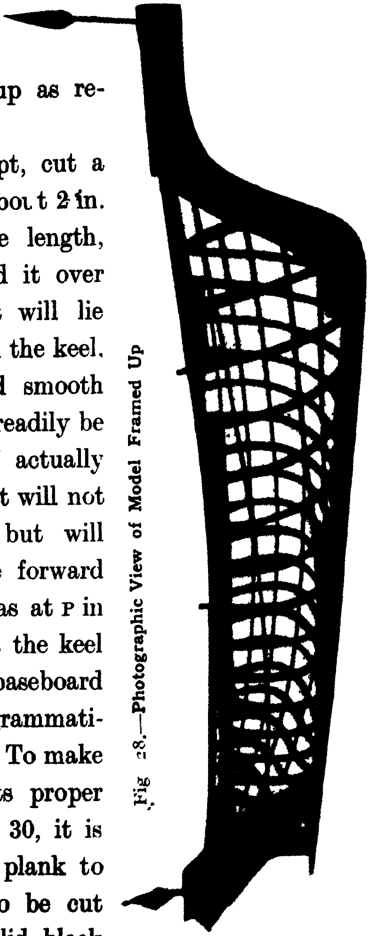


Fig. 28.—Photographic View of Model Framed Up

For a first attempt, cut a piece of rough stuff about 2 in. wide and of suitable length, and attempt to bend it over the ribs, so that it will lie flat into the rebate in the keel, while lying fair and smooth on the ribs. It will readily be found that, short of actually distorting the wood, it will not fit into its place; but will touch the keel at the forward and after ends only as at P in Fig. 29, which shows the keel at K, moulds M, and baseboard B, and indicates diagrammatically what happens. To make the plank fit into its proper place as at P in Fig. 30, it is necessary to cut the plank to a curve, the part to be cut away being shown solid black

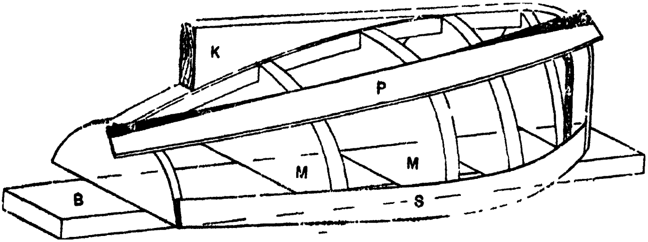


Fig. 29.—Fitting the Garboard Strake

in Fig. 29. After this preliminary cutting into shape, it will be found that a good deal of careful planing must be done to the edge of the plank before it fits properly.

This preliminary experiment is to show the method of fitting the garboard strake, as the plank next to the keel is called. This plank is always to be fitted first, the next plank to be fitted being the garboard strake on the opposite side of the keel, the right-hand or starboard strake acting as a pattern for cutting the left-hand or port garboard strake, the hull being planked alternately. The sheer strake s (Fig. 29) should next be fitted, and this usually presents no

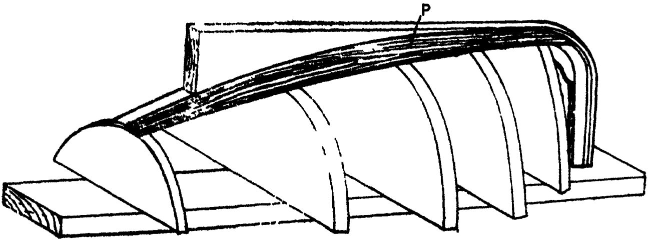


Fig. 30.—Garboard Strake Fitted

difficulty, as the curvature is not so pronounced. When these four planks are in place, the plank next the garboard is fitted, and as the timber—before it is cut to shape—laps over the plank P already fitted, as at A (Fig. 31), it is quite a simple matter to mark off the shape of the edge from the inside of the hull with a lead pencil as at L (in Fig. 31), thus considerably saving time and trouble.

At this stage it is as well to note that the edges of the planks must fit fair and square against each other for the whole length of the plank, and at all points along its length the joints between the edges of the planks should be perpendicular to the surface, as shown at A in Fig. 32. If the plank edge is left square, the result of bending the plank into position will be that the edge will assume a curve, or be " in wind," and consequently it is necessary so to shape the plank at the edge that it will be perpendicular to the surface for its entire length.

To ensure the best work, all the planks should run from end to end of the boat, and there should be the same number in the middle or at the midship section as at the ends, or at the bow and stern as at C, D, and E (Fig. 32), where it will be noticed that, although the sections are of different size, the same number of planks are used throughout, but are narrower at the ends than in the middle, somewhat after the fashion of the staves of a barrel. The planking should proceed alternately, by fitting planks

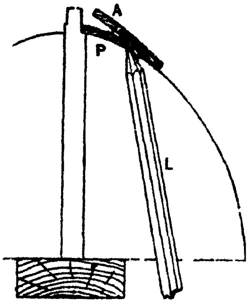


Fig. 31.—Marking off Second Plank

to the garboard side, and then to the sheer side until there only remains room for one more plank, known as the "filling plank." This requires most careful fitting, as both edges must be fitted at once, but by the time all the other edges have been fitted this work will not seem so impossible as at the beginning.

When the boat has been completely planked, remove the moulds except two from the hull, and proceed to fit the deck beams. Three of these should be sufficient, one about amidships, one forward and one aft; but, of course, the arrangement of machinery, etc., will govern the precise disposition of the deck beams, although, in all cases, the deck beams must be fitted against the ribs. The method to be employed is shown in Fig. 33, P being the sheer strake, C the gunwale, D a deck beam about ⅜ in. by ⅜ in. sawn to the camber of the deck, R a rib, and K a knee of hard wood glued and screwed on.

In cases where an open cockpit or machinery

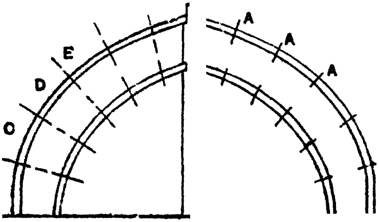


Fig. 32.—Spacing off the Planks

space is used, and surrounded with a coaming, the method of using half-deck beams is shown in Fig. 34, P being the plank, G the gunwale, D a short sawn deck beam, and K the knee. The coaming C is screwed to the thickened end of the deck beam by a brass wood screw S. If a propeller is to be fitted, the dead wood must be carved to form a boss B (Fig. 35) for the propeller shaft, and a rudder post fitted as at R. This is simply mortised into the keel at one end and secured with a brass plate P at the other. The rudder stem passes through the hole S, bushed with brass tube, the rudder being hung at the bottom of a pivot passing through the plate P. The hull may be finished outside with good water-resisting varnish, and the interior afterwards painted any suitable colour.

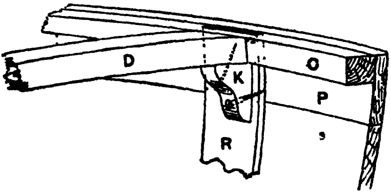


Fig. 33.—Fitting Deck Beam

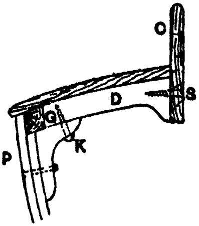


Fig. 34.—Half-deck Beam and Coaming

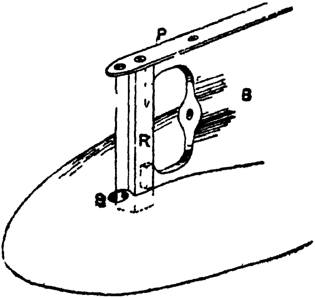


Fig. 35.—Fitting the Rudder Post

CHAPTER VI

A Model 10-rater Racing Yacht

MODEL racing yachts can be built in many different ways and to numerous rating rules, each of which has some advantage or other, and just as many objections. For the sake of an example in model yacht building a model 10-rater designed under the length and sail area rule has been chosen, but those who may wish to build for themselves a racing boat under any other rating rule can easily substitute the dimensions and form of any other boat, and follow the same general principles of construction that will be described for the 10-rater. Nevertheless, the L. and S.A. rule is a simple and easy one to build to, produces a fast boat, and is still very much used all over the country, despite the claims of 12-metre models and other classes of racer.

The hull lines are given in Figs. 37 and 38 and the body plan in Fig. 39. The latter is reproduced on a larger scale and should be enlarged to full size before starting to build the model. A full-size drawing is always advisable.

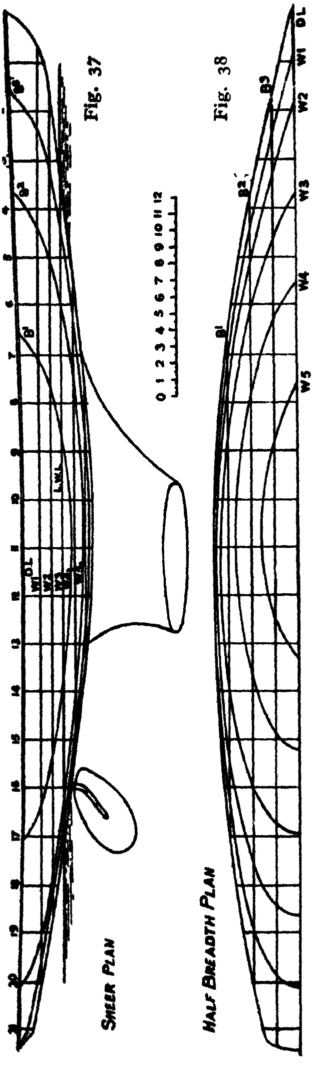
It may be explained that the rating rule for 10-

raters is ascertained by the following formula: $\frac{L \times S A}{6{,}000} = 10$; where L is the length on the load-water-line with the boat fully rigged, and S A the sail area in square inches. These two factors when multiplied together and divided by 6,000 must not exceed 10. The design provides a load-water-line length of 40 in. and a sail area of 1,500, consequently it works out as follows: $\frac{40 \times 1{,}500}{6{.}000} = 10.$

These dimensions give a long boat, which must be very light in the hull, while an allowance of 1,5C0 sq. in. of sail should be quite adequate to drive the hull at its maximum speed.

Hull.—The hull can be built in any of the different ways described in preceding chapters, though there is little doubt that wood is the best material to use for yacht construction. After all, it is the natural material for a small boat, and it is easily worked and a fine finish can be obtained.

Moulds.—The system it is proposed should be adopted for the construction of the present model is the plank system, as being more like the real thing, and if proper care and attention is taken the result will be a very handsome and shipshape job. The lines of procedure are detailed in the earlier chapters, and only sufficient information on constructing the hull will be given as is necessary for this particular example.



Figs. 37 and 38.—Hull Lines of 10-Rater

The baseboard may be a nice straight piece of deal about 3 in. wide and 2 in. thick, nicely planed up square, care being taken to see that it is straight.

The moulds can be cut from ⅜-in. thick wood; the smaller sections can be solid, and the larger ones built up from several pieces. The external shapes of the moulds are to be those given on the body plan (Fig. 39). less an allowance for the thickness of the planking and the ribs, in this case ⅛ in. for the planks and ⅛ in. for the ribs. When marking out the moulds draw a centre line, also the L.W.L. at right angles to it, and make the length from the L.W.L. to the bottom of the mould the same on every mould, so that when they are all standing upright the load water-lines will all coincide.

As the boat will be built bottom upwards the " bottom " of the mould will be on the " top " or deck part of the hull, and it is necessary that the length of the mould from the L.W.L. to the bottom is such that the hull when planked will be above the level of the baseboard. A suitable length for the 10-rater moulds is 7½ in. from the L.W.L. to the bottom. When all the moulds have been cut they are to be checked into the baseboard for a depth of ¼ in., and the centre line of each mould must be on the centre line of the baseboard. The result so far will now appear as in Fig. 40. Now test the moulds for accuracy, and see that the load water-lines on the moulds are all level and the centre line is really straight and true.

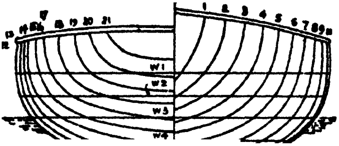


Fig. 39.—Body Lines of 10-Rater

Keel.—The next thing is to prepare the keel, stem and stern posts and to fix them to the moulds. The shape of the keel is shown in Fig. 41, which also gives other details of construction. The keel should be sawn to shape from good sound mahogany, either in one continuous piece or built up with sound scarved joints from two or three pieces, as indicated in Fig. 41 at A and B. A keel built in this way is stronger, as the grain of the wood runs better.

The keel should be ¾ in. wide and an average of 1 in. deep. It should be shaped with chisel, gouge, spokeshave and plane to the proper profile, as shown in Fig. 37.

Now cut the stern block or fashion piece C (Fig. 41) from good sound mahogany, and shape it accurately to the external shape as given by the body plan (Fig. 39). It extends from midway between sections 19 and 20 to the stern. It is to be checked on to the keel piece, glued, dowelled and screwed to ensure a sound joint, as shown in Fig. 41.

The rebate D, ⅛ in. deep, is then to be cut to accommodate the planking. Afterwards the inner part of the block is to be hollowed out as much as possible. A rebate is to be cut along each side of the keel as shown at E, leaving a parallel portion ¼ in. wide in the centre. The rebate should conform to the curvature of the hull, and is continued right along to the stem and up it to the deck level.

Now cut notches in the centre of all the moulds for the keel piece to fit into, as shown at A in Fig. 40. The keel piece is to sink into the moulds until its upper edge (as the moulds stand) is ¼ in. above the edge of the mould. If all is correct the rebates on the keel will now be ⅛ in. above the mould, but will

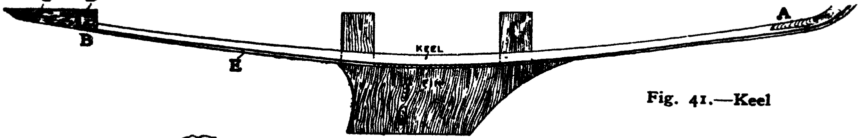


Fig. 41.—Keel

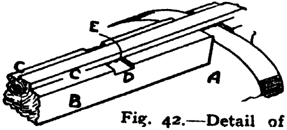


Fig. 42.—Detail of Fixing of Moulds

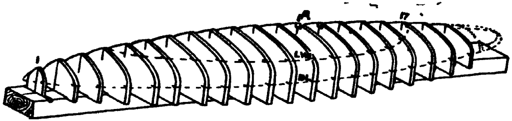


Fig. 40.—Moulds in Position

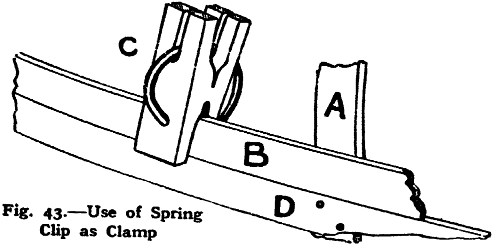


Fig. 43.—Use of Spring Clip as Clamp

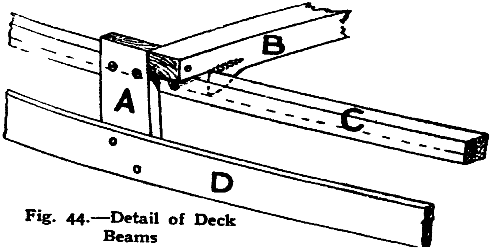


Fig. 44.—Detail of Deck Beams

conform to their general lines. This is shown in Fig. 42, where A is a mould, B the keel, C the rebate.

Ribs.—It is now necessary to prepare and fit the ribs. These should be of elm if it can be obtained, otherwise oak or mahogany can be used. The ribs should be ⅛ in. thick and ⅜ in. wide. To secure the ribs to the keel, cut notches or joggles E (Fig. 42) in the keel, into which the ribs can fit. Those for sections No. 7 to the stern, being nearly flat, can be pierced right through the keel; but the bow sections will have to be cut separately from each side of the keel.

As the ribs are inside the hull or under the plank, it is necessary to cut little grooves across the rebated portion of the keel to ensure them finishing up flat and flush with the rebate, as shown at D. Before cutting these notches the stern block should be blocked up to its proper height, with a packing piece between the under side of the stern block and the baseboard. The stem should be blocked up in a similar manner, and the keel held in place in the moulds by means of a few panel pins partly driven home so that they can easily be withdrawn.

Now prepare the fin by cutting it to the shape shown in Fig. 41, and make it from ⅛-in. thick oak with the grain vertical. Cut slots through the keel for the two legs to pass through, and a groove ¼ in. deep between them to accommodate the fin.

The next item is the bending and fitting of the ribs. They should be cut to length, and as far as possible should be fitted in one piece from gunwale to gunwale. They should be glued and pinned to the keel, using brass pins, and fastened at the bottom with a screw into the mould, a sufficient length being left on the ribs to allow of this, as after the planking is fitted these projecting parts can be cut off. Some of the ribs may need steaming or sponging with boiling hot water to render them pliable enough to lie flat on the moulds. Fix all the ribs in the same way and leave the job to set for a day, after which the planking can be taken in hand.

Planking.—The planking of the hull is probably the most difficult part of the work; it must be well done or the boat will leak. The planks must also "run" without undue twisting or straining, otherwise the hull will be distorted.

Before actually starting the planking it is desirable to be quite sure that the ribs and framing generally are quite fair and true. Test the alignment of the L.W.L. by means of a straight-edge blocked up to the correct level and temporarily held in place with clamps. The straight-edge should be vertical or perpendicular, and a set-square applied from the back of this to the side of the moulds should show that the L.W.L. lines marked on each mould are in line or level.

The next procedure is to obtain a splining batten and test the ribs for correct curvature longitudinally. As previously explained, it will be found that the ribs will need a little bevelling on the forward sides of the forward sections and on the after sides of those abaft the midship sections Nos. 11 and 12.

Brief consideration shows that if a strip of flat wood, say 1 in. wide, be laid along the ribs of the boat, it will not lie flat unless it is able to follow the curvature of the hull in a natural manner. Therefore to get the planks to fit nicely into place they must be shaped. They are seldom, if ever, parallel strips. The shaping, or variation in breadth of the plank, must be such that with but few exceptions each plank is continuous from end to end of the hull, wider in the middle and tapering towards the stem and stern.

The lower planks below the bilge, forming the "floor," are somewhat differently shaped, and the lowest of all terminate at the rebate on the keel piece. They must work into the rebate easily, and of course nothing in the way of odd tapered bits to fill up with can be tolerated. The whole success of the hull depends on this shaping of the planks, and it must have every attention. To commence actual work, obtain sufficient material, ⅛-in. thick pine, cedar, or Honduras mahogany. This must be as even and straight in grain as possible, any piece with a suggestion of a knot or shake being rejected as unsuitable for planking.

The first plank to fit is the garboard. This plank fits up to the keel-piece and lies in the rebate. It should be about 1¼ in. to 1½ in. wide at the midsection. Its shape can be ascertained by taking a suitable strip of fairly thick paper with one edge perfectly straight and placing this edge in the rebate in the keel at its lowest point. Rub the paper where it overlaps the edge of the rebate, and the curvature of the first plank is obtained. Transfer this shape to the timber and cut it accordingly (a fretsaw is handy for this work). Try it in place, and with the aid of small planes carefully work at it until it is a perfect fit along the keel. Take care that the plank fits for the whole of its width as well as its length. Fit the other garboard strake in a similar manner. It can be marked off from the first. as corresponding planks are always the same shape, as both sides of the hull are alike.

The surfaces of the planks, ribs and rebates, where they join, should be given a coat of good varnish and the planks secured in place to the ribs with fine screws (brass) or, preferably, No. 90 copper pins ⅜ in. long. Brass screws, ¼ in. No. 0, are best used where the plank ends lie in the keel rebate and also where they fit into that on the transom.

Fit the plank next to the garboard either by the use of a paper pattern or by direct marking off, taking every care to make the plank butt up closely against the garboard. The planks should fit closely, but are not to be forced together, nor should a space be left for filling in with caulking material. For a model a well-fitted butt-joint is quite satisfactory.

A useful tip when fitting the planks is to hold them in place with small spring-pressed clothes clips. They are very cheap, and hold the plank in place if used somewhat as shown in Fig. 43, where A is a rib, B the plank to be fitted, C the clothes peg or cramp, and D a plank nailed to the ribs.

Continue with the planking until the gunwale or topmost plank is reached. This can be shaped but should not be fixed until the deck beams have been fitted. The planking will now have a somewhat ridged effect, which is easily remedied by vigorous glasspapering until a smooth surface is obtained. The inside of the hull is to have two or three good coats of shellac varnish, which may very well be applied before the exterior is glasspapered as it makes a considerable difference to the stiffness of the planks.

The inwale must next be fitted. This should be a length of oak or ash ¼ in. square, and is fitted to the inside of the ribs ⅛ in. down from the line of the under side of the deck. It is tapered to fit the stem and checked into the stern block or transom. To fit this it will be necessary to cut away the moulds, which can readily be accomplished with a keyhole saw. The inwale is to be screwed in place with ⅜-in. No. 0 brass screws through the ribs.

The baseboard may be found somewhat inconvenient and may be removed while the inwales are being fitted; but before doing so make some chocks, or shaped wooden blocks, into which the boat can be placed. The faces of these chocks should be covered with felt where they touch the hull. Mount these on a baseboard, also other blocks to check fore-and-aft movement, thus making a secure stand on which the hull can stand while the interior work is going on.

Deck Beams.—The deck beams are now to be fitted. They should be cut from hard wood ¼ in. thick and ½ in. wide, cambered to suit, and shaped at each end as shown in Fig. 44, where A is a rib, B a deck-beam, C the inwale, and D the planking. The deck beams are cut to fit alongside the ribs and are therefore able to be fitted before the moulds are removed, thereby obviating any chance of the hull getting out of shape and also making it firmer to work on. They are secured with a ½-in. No. 0 brass screw through the inwales, and further secured with a fine pin through the deck beam and into the rib. It is wise to drill a fine hole through the deck beam to avoid any risk of its splitting.

The deck beam at section No. 11 is not continuous, as a hatch has to be fitted at this station, while that at section No. 16 is to be made from ⅝-in. thick stuff to accommodate the rudder post. It should be shaped as will be shown later on, and may be omitted entirely at this stage. The deck beams at sections Nos. 7, 8, 12 and 13 are to be checked into and secured to the extensions of the fin, shown in Fig. 41.

When the inwales and deck beams are fitted the spaces between the inwale and deck and between the inwale and the gunwale are to be filled in flush with soft pine secured with varnish and pins, the upper surface cleaned off flush and true to the sheer line, while the outer surface is to be cleaned up fair and true so that the gunwale can lie flush up against it, thereby making a strong rim or edge to the hull.

The gunwale is now to be fixed in place, and the upper edge cleaned off flush with the deck beams so that the deck itself can fit down closely on to the whole lot. The stem and stern blocks or fashion piece can be cleaned off at the same time.

Now remove the moulds from the hull. Most of them will come away intact with a little coaxing, but any that may prove to be obstinate should be cut through with a keyhole saw and removed in pieces.

Two longitudinal stiffeners D and E (Fig. 45) of mahogany ¼ in. thick and ½ in. deep. are to be fitted from the stem to the transom. They must be checked into the deck beams and can be screwed to the stern head and to the transom or fashion piece, and should also be screwed to each deck beam with ½-in. No. 0 screws. By using two pieces in this way ample strength is assured. and there is a convenient gap to enable the mast and rudder post to pass through. Fit an intermediate stretcher F of ¼ in. by ¼ in. hard wood between the beams at sections 10 and 12. and into this fix the short deck beams G for section No. 11, all as shown in

Fig. 45. The gaps between the fin and the longitudinals as shown at A should be filled by packing pieces of pine B, and the whole screwed together. This forms a very strong and rigid hull and distributes the strains caused by the fin keel over a wide area. Further strength is given by the knees C, which are glued and pinned in place as shown in Fig. 45. At sections 3, 6, 15 and 17 cross struts between the longitudinals and ribs are to be fitted as indicated in Fig. 46, where A is the deck beam, B and C the longitudinals, D and D′ the struts, E the rib, and F the fin. These struts should be fitted as shown, the lower ends being secured with a ½-in. No. 0 screw right through the planking. They can be cut from ⅜-in. wide by ¼-in. thick hard wood, and should be shaped to an oval section to reduce weight.

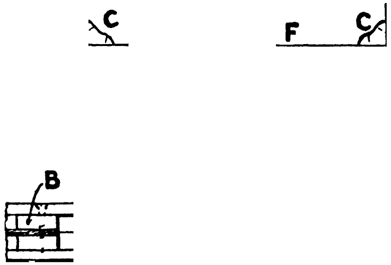


Fig. 45.—Half Plan on Deck Amidships

Hull and Deck Fittings.—The rudder and post is clearly illustrated in Fig. 47, and consists of a length of thin brass tubing A ⅜ in. in diameter, bushed internally at the top and bottom, and drilled ¼ in. to accommodate the rudder post B, which may be made of aluminium. Its lower end is curved, as shown, and split with a hack-saw. Into this slot is fitted the rudder blade C, likewise of aluminium. It is secured with small rivets passed through the curved stem of the rudder post and the rudder blade. A small collar D should be slipped over the post to form a lower bearing.

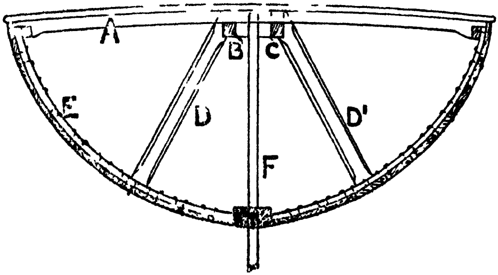


Fig 46—Cross Section Showing Hull Construction

The brass tube A (Fig. 47) may be fitted to the hull by drilling a hole ⅜ in. in diameter through the keel piece and also through the special deck beam E. Every possible care should be taken to ensure this tube being truly central and perpendicular, as on it the steering qualities of the hull will depend to a very great extent. The tube will be all right if it fits tightly and is secured with a red-lead joint, although a neat metal plate can be fitted to enable it to be screwed to the deck beam if desired. The tube should project $\frac{3}{8}$ in. above the level of the deck beams.

The only other fitting that must be secured before the deck is fixed is the mast step, Fig. 48. This consists of an aluminium alloy plate $\frac{1}{2}$ in. wide and 3 in. long, shaped as shown. The holes are $\frac{1}{8}$ in. in diameter, spaced $\frac{1}{4}$ in. apart, and are to accommodate a pin on the foot of the mast. This plate is to be screwed to the keel piece with four screws, and must be very secure. Also the row of $\frac{1}{8}$ in. holes must be in line and on the centre line of the boat.

The deck can be cut from one piece of $\frac{1}{8}$-in. yellow pine, if a sufficiently good piece can be procured. If not, it will be best to use two pieces, joined along the centre by a strip of $\frac{1}{8}$-in. thick mahogany arranged so that the joints come over the centre line of the longitudinals, to which they may be fixed with fine pins or No. 000 screws.

The deck should slightly overlap the hull sides and be finished as a bead with a half-round section. It may be attached by varnishing all the deck beams, etc., and be secured with fine pins. As the commercial $\frac{1}{8}$-in. material will need nicely planing and glasspapering, it will only have a thickness of $\frac{3}{32}$ in. or so when finished, but this is ample. The deck should now be lined out to represent planks, and the effect of a covering board obtained by scribing a

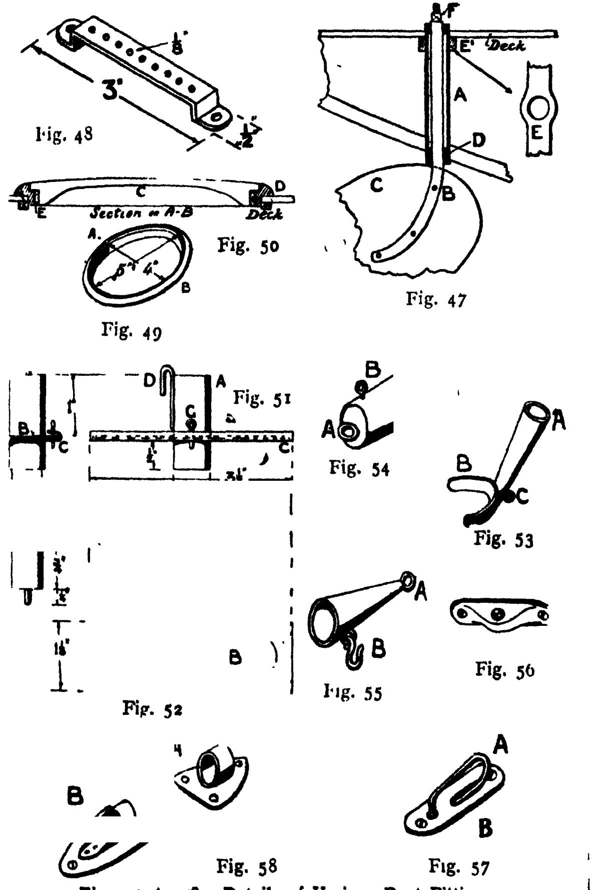


Fig. 48

Fig. 47

Fig. 50

Fig. 49

Fig. 51

Fig. 54

Fig. 53

Fig. 52

Fig. 55

Fig. 56

Fig. 58

Fig. 57

Figs. 47 to 58.—Details of Various Boat Fittings

line ½ in. in from the hull side, and carefully staining it to match the mahogany work. Of course, the lines representing planks will terminate at the coverboard line. The whole exterior of the hull may now have a finishing rub up with finest glasspaper, and be painted or varnished as desired; but varnishing is probably the best, as it reveals the workmanship of the hull.

The deck can also be varnished at the same time. Be sure to use a good quality varnish and one that is guaranteed not to discolour when exposed to the action of the water. Several coats of varnish will be needed. Each one must be allowed to set dead hard before applying the next, and the work should be rubbed down between each coat with pumice powder and water to ensure a fine glossy finish. Keep the boat in a warm dry place free from dust while the varnish is drying off. This will take a long time, but the other deck fittings, spars, sails, and so forth can be made during the varnishing period.

The hatch cover and rim is perhaps the best thing to make next. This could be made wholly of wood, but looks clumsy. By far the best plan is to buy or make an oval metal rim and fit a mahogany top to it with a cork or wooden piece inside it. Figs. 49 and 50 show the pieces, and also give the dimensions; but the exact size and shape are of no great consequence, and may be arranged to suit individual requirements; they should in any case be large enough to admit the hand into the hull to enable it to be sponged out as occasion requires. Another point that must be borne in mind is that as far as possible there should be no sharp edges or cranks into which any

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ropes or cords could catch, as if there is a chance for the main sheet to foul anything it will almost certainly do it on the slightest provocation. A cast aluminium rim of the shape shown in Fig. 50 obviates this defect. As can be seen, the mahogany cover C is arranged to fit into a recess cast in to the rim or covering D, and the projecting part of the wooden cover is faced with sheet cork E. The rim is secured to the deck with four small countersunk screws.

The adjustable mast tube (Figs. 51 and 52) next calls for attention, and can be made throughout from thin brass. It consists of a short length of thin brass tubing A, $\frac{3}{8}$ in. in diameter, brazed to a baseplate B, which is free to slide in the footing C screwed to the longitudinal beams. The hook D of $\frac{3}{32}$-in. brass wire is brazed to the tube A and acts as a gooseneck or support for the main boom. The footing C has a long slot cut in it to allow the mast tube to pass through. A series of holes in B is provided, as is a centering hole E in C, and a brass wire pin G holds the mast tube in place. The lower end of the mast has a ferrule F with a $\frac{1}{8}$ in. diameter centre pin to engage the footstep already fitted to the hull.

The gaff jaw (Fig. 53) can be built up from sheet brass, and comprises a tapered ferrule A to suit the gaff. The jaws B are cut from $\frac{3}{32}$ in. by $\frac{1}{4}$ in. strip brass, and brazed or silver-soldered to the ferrule. The angle of the jaws to the ferrule is to be approximately the same as the gaff makes with the main mast when in normal position. The small screw-eye C is provided to accommodate the sail lashing, and can be soldered in place.

The main boom ferrule (Fig. 54) is somewhat similar to the gaff jaws, but the end is closed by a disc and has a stout screw eye A brazed into it, to fit over the hook D on the mast tube. The small eye B is for the mainsail lashing, and may be soldered in place.

The jibboom fitting (Fig. 55) is similar to that on the main boom, but somewhat more tapered. The eye A at the end is to take the sail, while the hook and eye at B is the attachment to the bowsprit.

Stay plates are shown by Fig. 56, and can be purchased for a few pence from any high-class model-yacht supply house. They are stamped from sheet metal, and, having smooth contours, do not foul the running rigging. They can be filed to shape from solid material if so desired ; but the stamped pattern is the better. as it is so light and strong.

Hook plates (Fig. 57) are very useful and can easily be made from thin strip brass about $\frac{1}{4}$ in. wide by $\frac{3}{32}$-in. thick. To this plate the hook A is brazed. The opposite end is turned down into a hole in the base-plate and thus prevents a hook or eye, which may be attached to it. from being accidentally shaken adrift. To release it when wanted, it is only necessary to lift the brass hook up clear of the hole, for which purpose a hard or springy brass wire is preferable.

The bowsprit is held in place by the two fittings shown by Fig. 58. The forward fitting A is screwed to the extreme end of the hull, while the shoe or inboard end B is secured to the deck at a few inches inboard, according to the length of the bowsprit. Both consist of a sheet-metal base-plate with a tubular collar or ring silver-soldered into place. The forward one A is narrow—about $\frac{3}{8}$ in.—while the after one B should be cut to a slope as shown to allow of fixing the heel of the bowsprit.

The automatic rudder is shown in Figs. 59, 60, and 61. Its use will be described later, but it should be made up with the other fittings. It consists of a **T**-shaped quadrant A with a bossing B brazed on. This bossing is to have a square hole cut in it, of a size to suit the rudder post, which should be similarly squared to fit as at F (Fig. 47). This square should not be parallel, but should taper, so that the quadrant can be secured dead-tight to the rudder post, for which purpose the cap nut B is provided. This screws on to the top of the rudder post and draws the joint up tightly. Every care must be taken to ensure that the rudder blade is in line with the centre of the leg of the quadrant.

The pin rack C is made from $\frac{5}{16}$ in. by $\frac{1}{32}$ in. brass strip as shown, and is drilled with holes through which the pins D can be inserted. The centering hole F should be drilled in such a position that a pin passes through this and through the quadrant leg when the rudder plane is truly in the axial plane of the ship or "centred." The extreme end of the quadrant leg E is turned down at right angles and drilled with a large hole, about $\frac{5}{16}$ in. in diameter. The small holes in the quadrant are for the main sheet hooks and may be full $\frac{1}{16}$ in. in diameter.

Masts and Spars.—The masts and spars can be made from good sound pine, straight-grained and free from any suspicion of knots or splits. The dimensions can be obtained from Fig. 62 by adding an appropriate amount to the dimensions given for the sails. Thus the main mast becomes 42 in. long from deck to truck, the main boom $40\frac{1}{2}$ in., the jibboom 24 in., and the gaff $23\frac{3}{4}$ in. The mast is $\frac{5}{8}$ in. in diameter where it fits into the mast tube, and should taper gradually to within a couple of inches of the truck, at which point it should taper abruptly to $\frac{3}{8}$ in. in diameter and terminate in a circular truck or cap. The mainboom should be $\frac{9}{16}$ in. in diameter in the centre and taper both ways, and the jibboom $\frac{7}{16}$ in. in diameter, tapering both ways. The gaff is of similar dimensions, but is largest at a point 6 in. from the gaff jaws.

Fig. 59

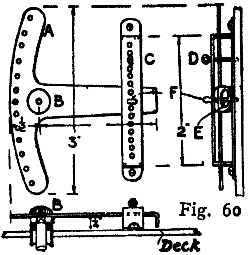


Fig. 60

Fig. 61

Figs. 59 to 61.—Details of Automatic Rudder

The best way to make these spars is to plane them up to the correct taper in square section, then plane off the corners, making them hexagonal, and finally making the material as circular in section as possible with the plane, finishing them off smooth with glass-paper. Afterwards give them a coat of varnish to keep them clean while fixing the various fittings.

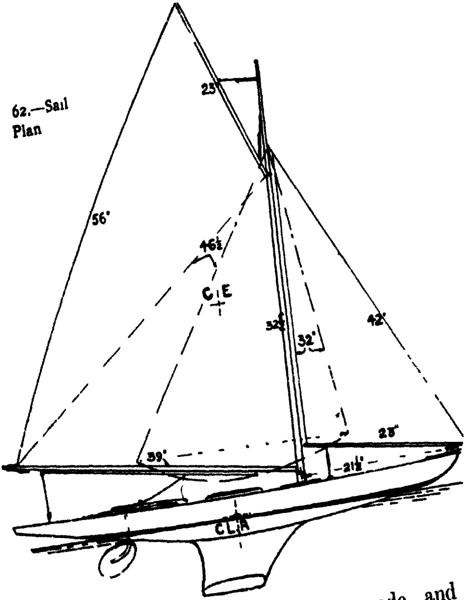


Fig 62.—Sail Plan

Sails.—The sails should next be made, and are best cut out from union silk. The material should be pinned with drawing-pins to a table or board, and marked out in pencil to the exact shape of the sails. An extra amount must be allowed if the edges are to be hemmed; but if the edges are to be bound with the usual prussian binding they can be cut to their shape with a very sharp penknife or razor. The utmost care must be taken when sewing the binding on to keep the sails perfectly flat. The essential feature of a good sail is that it should be flat, and it should be quite free from wrinkles or creases. Perhaps the best way is to tack on the binding after having creased it down the centre, and then to machine the two edges, somewhat as indicated at F in Fig. 63. If it is decided to hem the edges it can be done in an ordinary sewing machine if it has a "hemmer." A corner piece—triangular in shape—should be stitched to the sails at all the corners to give added strength for the eyelets, as shown at J in Fig. 63.

The spinnaker is shown dotted in Fig. 62, and can be made up to the sizes shown, also the spinnaker boom and fittings. These are shown in Fig. 64, and consist of a brass tube ferrule B, with a long hook and screw-eye C. This hooks into a shroud plate (Fig. 56).

Keel.—At this stage it is well to ascertain the exact weight of the lead keel. This is accomplished by placing the hull in water with all its sails and fittings complete, and then putting weights in the hull until she floats at the exact water-line, which should measure 40 in. Weigh these weights, and this will be the keel weight, about 9 lb. Cast a lead keel and screw it to the fin and then test the boat. It is easy to get the final adjustment by scraping off some of the lead or adding a little in the interior of the hull to get the exact water-line length and trim required.

Rigging.—Nothing now remains but to step the mast, securing it by two shrouds, one each side. Then fit up the bowsprit and jibboom, using the fittings already described in previous articles of this series.

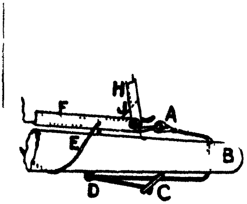


Fig. 63.—Detail of Sail Fastening

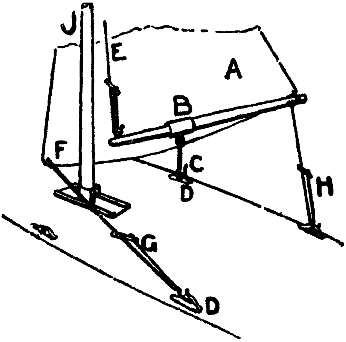


Fig. 64.—Detail of Spinnaker Rigging

The jibboom is shown in detail in Fig. 65, and is clothed with the jibboom ferrule M (Fig. 55). The jib stay K hooks into the eye at the end L of this ferrule, and is attached to a screw-eye in the mast by means of a hook and bowsie. The jib is secured to this stay by sewing on a number of small rings J, spacing them about 1½ in. apart. The eyelet in the foot of the jib is lashed to the hook on the jib stay as at L (Fig. 65).

A line is then taken from a screw-eye D immediately aft of the ferrule to another screw-eye F, and made taut with the bowsie C. On this line runs another bowsie E, which has a cord taken through a ring hooked into the eye F, and terminates in a flat rubber band G with a hook H at the end of it. It is convenient to mark the boom with ½-in. divisions as shown, so that once the best sailing position has been found it can be noted for future use.

At the inboard end of the boom is a "traveller" B, shown in greater detail in Fig. 63. This shows the end of a boom, and that it is drilled through at right angles near the end as at B. A cord reeves through this hole and terminates in a hook A which hooks into the eyelet in the foot ot the sail as at J. The other end of the cord has a bowsie C, and is taken through a small screw-eye D. This outhaul is used to draw the foot of the sail up taut.

The sails are further secured to the spars by the light cord E, which is sewn through the sail and turned round the boom as shown. This arrangement is used on the mainboom and on the jibboom.

The spinnaker hooks direct to a screw-eye on the mast; a backhaul with bowsie adjustment is shown at H (Fig. 64). The sail is set by means of the uphaul E, the action being to haul the inboard end of the boom up, thus depressing the outboard end of it and keeping everything taut and trim. A spinnaker sheet is attached direct to the sail as shown at F, while a bowsie G provides adjustment and hooks into a shroudplate D.

The sails can now be set, and it only remains to fit up the automatic steering gear, and the various ropes that are used in conjunction with it. These are all shown in Fig. 66, which is a diagrammatic representation of the various parts in place on the deck.

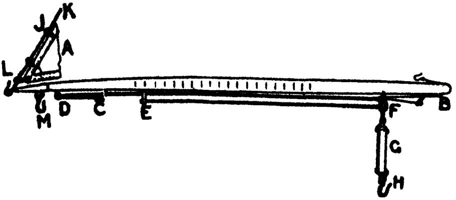


Fig. 65.—Jibboom Detail

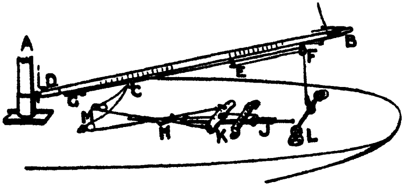


Fig. 66.—Automatic Rudder

The mast is shown at A, the mainboom ferrule at D, the outhaul at B, and the "beating sheet" at F. This hooks on to a wire "hawse" which consists merely of a piece of $\frac{3}{32}$-in. diameter wire bent to shape, the ends being turned over at right angles and riveted and sweated to circular deck plates as shown at L. A rubber disc to act as a buffer is an advantage as it tends to avoid spilling the wind from the sail when going about.

The beating sheet has an adjusting bowsie E running on the line G, which is kept taut with a bowsie.

Automatic Rudder.—To fit up the automatic tiller it is only necessary to see that the quadrant K is securely attached to the rudderpost and that the pin rack is well fixed to the deck. Now fix a small screw-eye into the deck on the centre line and about 2½ in. behind the end of the quadrant, also another screw-eye about 6 in. ahead of it. Then insert a rubber band through the hole in the arm of the quadrant. and make one end of it fast to a line leading to the after screw-eye. A similar connexion is to be made to the forward screw-eye, but in this case an adjustment must be provided by the bowsie as shown at H (Fig. 66) to enable the tension of the elastic to be varied at will.

Now fix two small sheaved pulley blocks just ahead of the forward screw-eye as at M, and through these lead the "running sheets" which terminate in one bowsie C. The running lines cross over as shown and hook into the holes in the quadrant. By this arrangement whenever the boom goes over to starboard the helm is put over to starboard and vice versa.

The action and use of this device is both simple and effective. Its chief use is in running before the wind, for as the wind pressure on the sail tends to drive the boat off her course, the rudder is automatically put over on the opposite hand.

CHAPTER VII

Building a Model Clipper : Description

IT is seldom that the model-maker turns his attention to those old craft that for ages have graced the seas, and which culminated in the famous clipper ships—fine fast sailing vessels that maintained communications between this country and the uttermost parts of the earth. It is of such vessels that this chapter deals, particularly the full-rigged ship of the period between 1840 and 1860, when these vessels were competing with steamships.

Consider Fig. 67. which is a photograph of a finished model of a vessel as built in 1866. Such ships had a tonnage of 1,100 tons or more, had a length of 210 ft. or thereabouts. beam of 36 ft., and depth of 21 ft. The model measures 42 in. long, 7¼ in. beam, and 4½ in. depth, having an approximate displacement of 14 lb. It is intended for actual sailing, and some simplification of the details is necessarily incorporated both in the hull and the masts. spars and sails. The length of 42 in. for the model results in a boat that is easily transported. yet enabling adequate and accurate detail to be shown. adding enormously to the interest of the work.

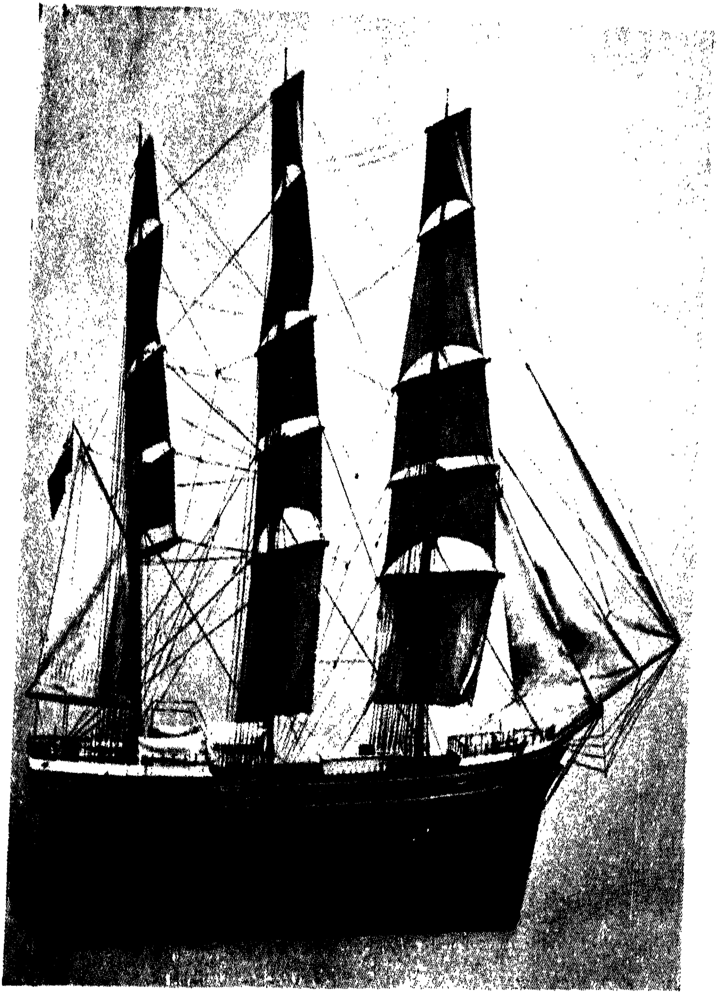


Fig. 67.—Show Model of a Clipper Ship

Fig. 68 shows the masts, spars and the sails corresponding to the finished model illustrated by Fig. 67, drawn from the same position, so that comparison and reference may be made between them.

The model may properly be termed a "ship" because it fulfils the definition of a ship in that it has three masts all "square rigged." The masts are invariably made in at least three parts. These are called the lower mast, the topmast (which is the "middle" mast), and the topgallant mast. The highest part of the topgallant mast is known as the "royal" mast.

The three masts are also designated by their position on the hull. The "fore" which is always the one nearest the bows, or front; the "main," which is the tallest mast, usually near the centre of the boat; and the "mizen," which is the aftermost mast, or that nearest to the stern. The masts and components, therefore, are named as follows, the numbers referring to Fig. 68: (1) Fore lower mast, (2) fore topmast, (3) fore topgallant mast, (4) main lower mast, (5) main topmast, (6) main topgallant mast, (7) mizen lower mast, (8) mizen topmast, (9) mizen topgallant mast, (10) jibboom, and (11) bowsprit. These latter are used to set the head sails, and also to stay or support the masts, principally the fore masts.

The clipper ships were rigged with five sails per mast, as shown on the model. The sails are named after the masts that support them. Commencing with the foremast, the sails are named as follows : (36) Foresail, (35) fore lower topsail, (34) fore upper topsail, (33) fore topgallant sail, and (32) fore royal. Similarly, the sails on the main mast are named on the same system, and are as follows : (41) Main sail, (40) main lower topsail, (39) main upper topsail, (38) main topgallant sail, and (37) main royal.

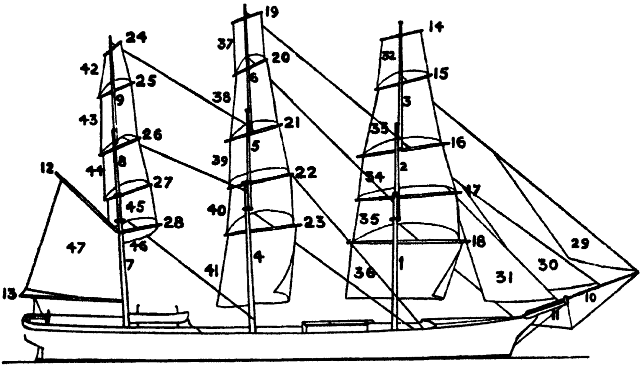


Fig. 68.—Masts, etc., of Model shown by Fig. 67

The mizen mast carries an extra sail (No. 47 in Fig. 68) known as a “ spanker.” It is a “ fore-and-aft ” sail, as its normal position is in line with the fore-and-aft centre line of the boat ; and for the same reason the headsails (Nos. 29, 30, and 31 in Fig. 68) are also known as fore-and-aft sails. The names of the sails on the mizen mast are as follows : (47) Spanker, (46) mizen sail, known as a “ cross-jack ” from the name of the yard which supports it (this sail is shown brailed up in Fig. 68), (45) mizen lower topsail, (44) mizen upper topsail, (43) mizen topgallant sail, and (42) mizen royal.

The head sails are as follows : (29) Flying jib, (30) jib, and (31) fore topmast staysail.

It will be noted that all the sails are either carried or supported by "yards," which cross the mast ; by "half yards," otherwise known as gaffs, which set on the after side of a mast, or on "stays," which are ropes that support a mast, or on booms. The names of these fittings are as follows : (18) Fore yard, (17) fore topsail yard, (16) fore upper topsail yard, (15) fore topgallant yard, (14) fore royal yard. (23) main yard, (22) main topsail yard, (21) main upper topsail yard, (20) main topgallant yard, (19) main royal yard, (28) cross-jack yard, (27) mizen topsail yard, (26) mizen upper topsail yard, (25) mizen topgallant yard, (24) mizen royal yard, (12) spanker gaff, and (13) spanker boom.

Having grasped the names of the masts, sails and yards, it is needful to consider the names and location of the standing rigging that is used to support the mast and that take the driving strains of the sails, apart from the running rigging.

All this gear, or as much of it as is necessary on a working model, is shown in Fig. 69.

Commencing with the foremast, it will be seen that the fore lowermast is supported sidewise by the fore shrouds (No. 2), which have ratlines or steps, thus forming ladders. The fore topmast is supported by similar shrouds (5) known as the fore topmast shrouds, as is the fore topgallant mast, with the fore topgallant shrouds (8). The foremast is further supported by the following : (25) Fore topmast standing backstays, (22) fore topgallant standing backstays, and (19) fore royal backstays.

The following stays also support the mast in a longitudinal plane : (11) Fore stay, (17) fore topmast stay, (16) jib stay, (15) fore topgallant stay, (14) flying jib stay, and (13) fore royal stay.

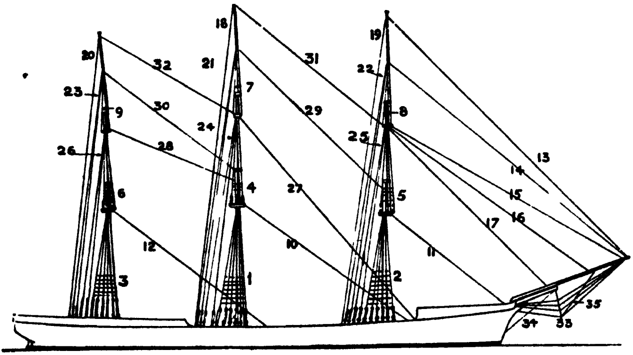


Fig. 69.—Rigging of Ship shown by Fig. 67

A number of stays are arranged between the foremast and the mainmast, and act as supports to both. These are named as follows : (31) Main royal stay, (29) main topgallant stay, (27) main topmast stay, and (10) main stay.

The mainmast is supported sidewise by the following stays : (1) Main shrouds, (4) main topmast shrouds, (7) main topgallant shrouds, (18) main royal backstays, (21) main topgallant standing backstays, and (24) main topmast standing backstays. Between the main and mizen masts are the following stays : (32) Mizen royal stay, (30) mizen topgallant stay, (28) mizen topmast stay, and (21) mizen stay.

The mizen mast is supported by the following ; (3) Mizen shrouds. (6) mizen topmast shrouds, (9) mizen topgallant shrouds. (20) mizen royal backstays. (23) mizen topgallant backstays, and (26) mizen topmast backstays.

The rigging of the bowsprit and jibboom is naturally an important matter, as it has a considerable strain to bear. To assist in preventing whip or bending, the bowsprit is fitted with spreaders, one of which is shown in Fig. 69 at (33). This is known as the dolphin striker (or martingale spreader). Bobstays (34) are used to support the bowsprit, while a martingale (35) supports the jibboom. The fore royal stay (13) is carried through the end of the flying jibboom, which on the model is merely a continuation of the jibboom, reeved through the dolphin striker and set up to the " knight heads."

The flying jibstay (14), jibstay (16), and fore topgallant stay (15) are also taken through holes in the jibboom, reeved through the dolphin striker and set up to the knight heads.

CHAPTER VIII

A Model Clipper : Hull, Deck and Fittings

The Hull.—The construction lines of the hull are the same as those given in Chapter I (Figs. 4, 5, and 6), and by the aid of this illustration a satisfactory result should be obtained, given reasonable care and common sense.

The body plan (Fig. 6) is shown to the deck line, the bulwarks and superstructures being built up on to the hull or deck, thus saving labour and waste of material. The method of making the hull will be on exactly the same lines as detailed for Figs. 4 to 9. Fig. 70 is a scale applicable to this model and the drawings in question.

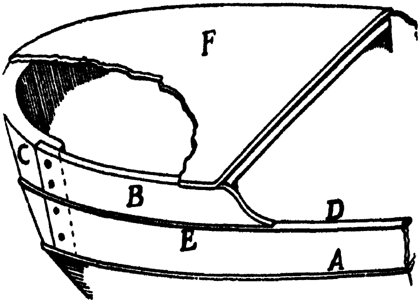


Fig. 70.—Construction of Poop

The dimensions of the hull when finished should be 42 in. over all, 7¼ in. beam, and 3⅝ in. deep (excluding lead keel) from deck line at section No. 8. The displacement will be about 14 lb., and of this total the hull will weigh about 2 lb.; it will vary according to the weight of the timber used and its finished thickness. The masts, sails and cordage will take another 2 lb., while the deck erections, rudder and paintwork will easily weigh another pound, thus leaving some 9 lb. available for the lead keel and for ballast.

Deck Erection and Fittings.—Having completed the hull and prepared the main deck, the next thing to do is to make the bulwarks, prepare and fit the forecastle, poop and saloon, as well as the other important deck fittings.

First of all fix the main deck to the hull with a few small brass screws into the beams and hull sides, at convenient places where it will be possible to get them out again if it should ever be necessary to remove the deck. Finish the edges of the deck to form a neat half-round bead as shown in the various illustrations. Now cut the bulwarks from a strip of thin pine or cedar not more than $\frac{3}{32}$ in. thick.

The poop and forecastle sides can be shaped from the strip used for the bulwarks and form one with it. At the stern a solid block of wood should be cut to shape and rebated to take the bulwark strip as shown in Fig. 70, where A is the bulwarks, B the poop side, C the shaped stern block or transom, and D the capping rail. This is made from mahogany $\frac{3}{16}$ in. wide and $\frac{1}{16}$ in. thick with rounded edges, glued and pinned to the bulwarks, and continued along the poop side as a strip or half-round bead as shown at E.

Cut and fit a deck F from pine $\frac{1}{16}$ in. thick to cover the poop, also shown in the profile illustration and plan (Figs. 71 and 72), from which all details and dimensions can be taken. This deck should also be finished with a half-round edge to match the beading. The forward end of the poop deck is to be supported by a beam $\frac{1}{8}$ in. thick and $\frac{1}{4}$ in. deep, cambered and moulded as shown in Fig. 71, and Fig. 73 at A. The space between the poop and main decks is to be filled in by a strip of wood $\frac{1}{8}$ in. thick, cambered to suit the decks. It should be painted with two coats of a flat white undercoating. When this is dry, draw the windows and doors, etc., with a waterproof indian ink, using a ruling pen for the purpose. These details are shown in Fig. 73, and to get a good effect the doors can be coloured brown and the panels shaded. Windows should be shown in dark blue fading away to white.

Now drill a $\frac{5}{8}$-in. diameter hole to accommodate the mizen mast. This hole is to go through the thin poop deck and the main deck, and to strengthen the poop deck at this spot glue a piece of $\frac{1}{4}$ in. thick pine, $1\frac{1}{4}$ in. in diameter, to the under side of it. Perpendicularly beneath this hole cut a square hole in the bottom of the hull for the mast to step into; make this hole $\frac{3}{8}$ in. square.

The forecastle is to be decked and enclosed in a similar manner to the poop, and details are given in the various illustrations, but particularly in Fig. 74, which is a view looking forwards and shows all the details.

The bowsprit B (Figs. 71 and 72) should now be made, and is fitted by passing it through a hole drilled in the knight head C and by means of a wood screw D into the main deck. Shape the heel of the bowsprit to lie snug on the deck; also glue a pad piece of $\frac{1}{4}$-in. pine under it to give a good hold for the screw.

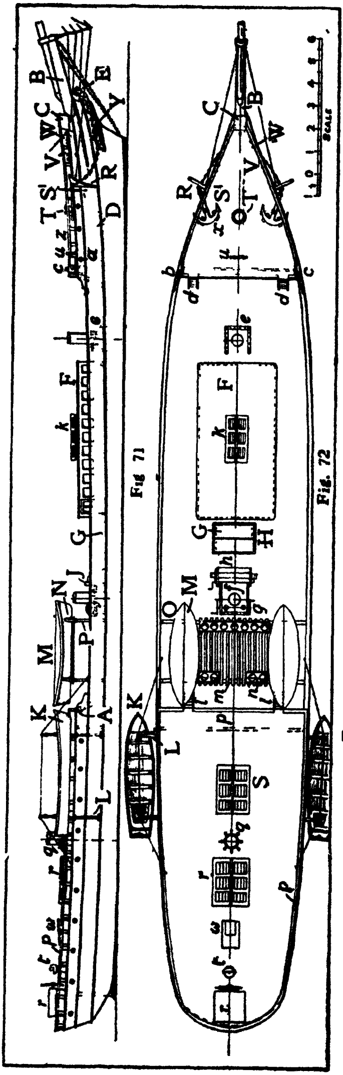
Drill holes for the foremast and mainmast, and cut square holes in the hull as described for the mizen mast. Carve a figure-head and fix it in place with the stringers as shown at E in Fig. 72. It is best to only temporarily fix the decks, etc., with a few fine pins, until all the deckwork is complete, after which the decks should be glued and pinned in place.

The saloon F (Figs. 71 and 72) can now be made from thin pine painted and varnished as described for the poop; but make it removable. Under the opening cut in the deck fasten a piece of leather to the bottom of the hull to act as a carrying handle. The edges of the deck opening should have little upstanding strips of wood glued and pinned to them, to make a watertight joint and prevent the saloon from being accidentally removed. The main hatch G (Figs. 71 and 72) can be made from mahogany, nicely varnished.

The coaming H is to be glued and pinned to the deck, which should be cut away so as to leave a $\frac{3}{16}$-in.

projection all round inside the coaming to support the hatch cover, which is merely a shaped piece of mahogany. Prepare and fix to the inside of the bulwarks a belaying-pin rail J (Figs. 73 and 74), which should be made from a strip of mahogany ¼ in. wide, ⅛ in. thick where it fixes to the bulwarks, and $\frac{1}{16}$-in. at the front. At intervals of 1 in. apart drill fine holes and insert turned metal belaying-pins as shown.

The ship's boats and davits, shown at K and L in Figs. 71 and 72, should be made by carving them from the solid, fitting thin wooden



Figs. 71 & 72.—Hull Lines of Model Clipper thwarts and stretchers as shown. For the davits, a piece of brass wire may be bent to the proper shape, flattened at the upper end and drilled to take a wire eye. Fit control or stay ropes, also blocks and falls, all as shown in Fig. 71.

The two other boats M (Figs. 71 and 72) are made in the same way, but are covered with a canvas top, or may be shaped correctly, externally, and merely left solid. They are carried in chocks N (Figs. 71 and 73), cut to shape from $\frac{3}{16}$-in. thick wood, and mounted on boat beams O, made from mahogany $\frac{1}{4}$ in. deep and $\frac{1}{16}$ in. thick, supported on $\frac{1}{4}$ in. square posts P with angle pieces or knees Q glued in the corners.

The forecastle may now be fitted up, and Figs. 71 and 72 give full details. The anchor cat heads R should be cut from oak $\frac{1}{4}$ in. thick and glued and pinned to the hull sides. The anchors are shown at S, and can be built up from brass strip and rod, or a pattern can be made and castings in aluminium procured.

The capstan T can be turned from boxwood or other hard wood and glued in place on the deck, while the " bitts " are simply made from $\frac{3}{16}$-in. square wood. The bollards V and fairleads W are made from metal filed and turned to shape and fixed to the deck with fine pins. Anchor chocks X are simply cut to shape from little blocks of pine, and glued and pinned to the deck, while the arrangement of the anchor cable and other gear is quite clear. The hawse hole Y need not go right through into the hull, as it is not intended to unship or use the anchors.

An open wood rail and posts as shown at Z (Fig. 71) can now be prepared from mahogany, and fixed to the deck with glue and pins after the sidelights *a* have been fitted.

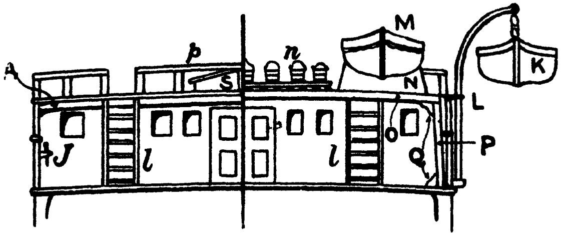


Fig. 73.—Views Looking Towards the Poop

Port and starboard lanterns and boxes as shown at *b* and *c* in Fig. 71 are to be carved from wood and fitted with little glass lenses as shown. The boxes are simply made from $\frac{1}{16}$-in. thick wood glued and pinned to shape.

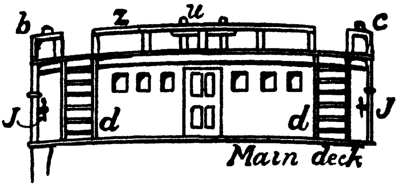


Fig. 74.—Looking Towards the Forecastle

The starboard lamp, which is fixed to the right-hand side of the boat when looking forward, is to be green, while the port lantern (on the left-hand side) is to be bright red.

Access to the forecastle deck is by means of the two ladders shown at *d* in Figs. 71, 72. and 74. These can be made from $\frac{1}{16}$-in. thick wooden strips $\frac{3}{16}$ in. wide, cut to lengths and glued together ; but a better and neater job is to make them from thin metal soldered together, and to have them silver-plated and lacquered. In each case they should be securely pinned to the deck.

The fittings in the waist of the ship should now be completed. They are shown in Figs. 71 and 72, and comprise a fife rail *f* round the main mast, a pump *g*, windlass *h*, and riding bits *j*. The latter are similar to those described for the forecastle, and Fig. 75 gives clear details of the fittings round the main mast.

The pump can be made as a dummy. The barrels *a* are made from pieces of round wood $\frac{1}{4}$ in. in diameter and $\frac{1}{2}$ in. long, glued and pinned to the baseboard *b*, which for convenience is made sufficiently large to accommodate all these fittings, so that they can be made up and assembled straight away on to the baseboard, and the whole thing fixed in place on the deck itself.

The baseboard has a hole through it to accommodate the mast, as shown. Practically the whole of this fitting can be made from wood, except, of course, the pump shaft *c*, which can easily be bent to shape from thin iron wire, as can the connecting rods *d*. The pump flywheels and handles *e* can be turned from a brass disc, and the spokes cut out from the solid.

The saloon skylight *k* (Figs. 71 and 72) is simply made from $\frac{1}{16}$ in. mahogany, and the windows glazed with thin glass. The bars or rails are short pieces of thin brass wire inserted into holes in the wood. They should be finished in their natural colours and varnished.

Two deck ladders *l* give access to the poop, and should be made in the same way and at the same time as those for the forecastle.

Slats of pine $\frac{1}{16}$ in. thick and $\frac{3}{16}$ in. wide are to be pinned and glued to the boat beams o as shown at *m* in Fig. 72, and a railing made from brass wire erected round the deck thus made. On this deck are fixed the racks and little fire buckets *n*, all of which can be shaped from wood or bought ready made.

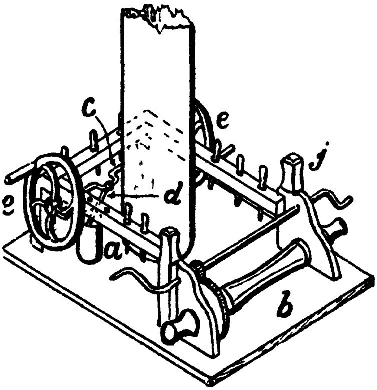


Fig. 75.—Detail of Fittings round Mainmast

The poop deck is to be equipped with wooden railings *p* made and filled in the same way as those on the forecastle. A spider band *q* surrounds the mizen mast, and the two skylights *r* and *s* can be made and fitted in the manner already described.

A binnacle *t* can be turned from hard wood or metal, while the companion hatchway *w* can be made without difficulty from $\frac{1}{16}$-in. thick mahogany.

The rudder and steering gear now call for attention, and Figs. 76 and 77 give the details. As can be seen, the rudder *a* is cut to shape from oak $\frac{3}{16}$ in. thick, and the stock is clothed with a brass tube of $\frac{1}{4}$ in. outside diameter. This is carried in another brass tube *c* of $\frac{1}{4}$-in. bore, which is to be fixed securely in the hull and extends upwards through the main deck *d* and poop deck *e*.

The foot of the rudder is supported by a pintle and eye, while the stock turns in the hull tube *c* and projects above it as shown. A crank *f* made from strip brass is now made and fitted to the rudder stock.

The wheel-box *g* should now be made from $\frac{1}{8}$-in. mahogany. The sides can be fixed to the deck, but the top should be removable to give access to the steering gear. This consists of a steel rod *h* $\frac{1}{8}$ in. in diameter, and screwed for the major portion of its length. It is carried in bearings made of brass tube, and fitted with two collars *k* to prevent end movement. The outer end carries the wooden steering wheel *l*, which is to be pinned securely to the screwed shaft. A nut *m* with a projecting peg and roller *n* is threaded on the screwed rod, while the peg is guided by the roller and two brass wire guides *o*, which are simply inserted into the ends of the wheel-box. Their purpose is to prevent the nut *m* from turning round, with the result that when the steering wheel *l* is turned, the nut *m* is screwed along the screwed rod *h*. This motion is transmitted to the rudder through the medium of the crank *f*, and a connecting rod *p*, which can be made by bending over the ends of a $\frac{3}{32}$-in. steel rod. The length of this rod must be such that the rudder is in line with the centre of the ship when the nut *m* is in the middle of the screwed rod. The illustration shows the rudder in this position, and dimensions can be taken from it with the aid of the scale.

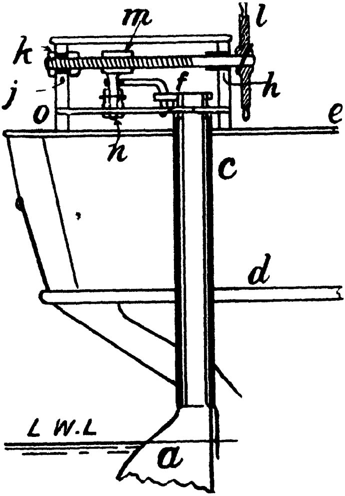


Fig 76

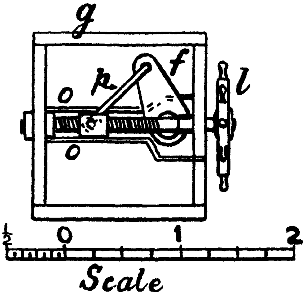


Fig 77

Figs. 76 and 77—Details of Steering Gear

The steering gear is shown in place on the hull in Figs. 71 and 72, at *v*, and should give a good idea of its location.

CHAPTER IX

A Model Clipper : Masts, Sails and Rigging

Masts and Spars.—The hull being sufficiently completed, the masts and spars may next be put in hand. and so far as they are concerned do not present any great difficulty. The masts and spars can all be shaped from good quality pine, free from knots and straight in the grain.

For the working model these spars are all made circular in section, although the originals are reinforced with sundry strips and are not always circular in section. The following tables of dimensions will act as a guide to the builder. The lengths are overall, except the fore, main. and mizen masts, which are given as "above deck" only. An extra allowance must be made to suit each individual boat for the below deck part of these masts.

The diameters are the maximum, and all the masts taper from the bottom upwards. The yards for the square sails taper from the centre outwards to each end or yard arm. The spanker boom tapers each way from the centre, while the spanker gaff has its greatest diameter near to the mast fork or "gaff jaws."

Meanwhile the main. fore and mizen tops can be

MASTS

Fore mast	5/8 in. diam.,	11 in. length above deck.
Fore topmast	1/2 in. ,,	7 in. length.
Fore topgallant mast ..	3/8 in. ,,	8 1/4 in. length.
Main mast	5/8 in. ,,	12 1/4 in. length above deck.
Main topmast	1/2 in. ,,	7 1/2 in. length.
Main topgallant	3/8 in. ,,	9 1/2 in. length.
Mizen mast	5/8 in. ,,	10 in. length above deck.
Mizen topmast	1/2 in. ,,	6 3/4 in. length.
Mizen topgallant	3/8 in. ,,	7 3/4 in. length.

SPARS

	Diam. in in.	*Lgth. in in.*		*Diam. in in.*	*Lgth. in in.*
Fore royal yard ..	3/16	5	Mizen royal yard ..	3/16	4 1/2
Fore topgallant yard ..	1/4	6 1/2	Mizen topgallant yard	1/4	6
Fore upper topsail yd.		9 1/4	Mizen upper topsail yd.	5/16	8 3/4
Fore topsail yard .	[illegible]/16	11	Mizen topsail yard ..	5/16	10 1/2
Fore yard .. .	3/8	5 1/2	Mizen crossjack yard..	3/8	13
Main royal yard .	3/16	13 1/2	Spanker boom ..	3/8	8
Main topgallant yard .	1/4	7	Spanker gaff	7/16	7
Main upper topsail yd.	5/16	9 3/4	Jibboom	5/16	9
Main topsail yard .	5/16	11 1/2	Bowsprit	3/8	10 1/4
Main yard .. .		14			

put in hand. A simple arrangement, and one that will look well, is shown by Fig. 78, which is a view looking upwards from the deck.

These tops are a species of platform and are mounted near the top of the lower masts; they serve to support the topmast rigging and also serve other purposes, including acting as a support for the bottom, or "heel," of the topmast. In Fig. 78 the lower mast is shown at 4, the mast cap at 5, and the platform of the top at 6. This can be cut from oak fretwood 3/32 in. thick, and should be 3 in. wide by 2½ in. long. A central square opening 1, known as the lubbers' hole, allows ropes to pass from above to the deck; but for the model take care to leave a support under the heel of the topmast. Underneath this platform are four small slips of wood ¼ in. by ⅛ in. The fore and aft pair 2 are known as the trestle trees, and are pinned to the mast, which should be flattened to receive them. The transverse pair 3 are known as crosstrees and are halved into the trestle trees.

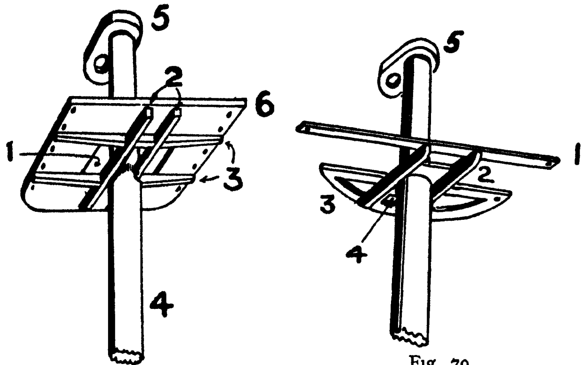


Fig. 78

Fig. 79

Figs. 78 and 79.—Main Top, Main Cap, and Topmast Crosstrees

The topmast is fitted in a somewhat similar way, but the platform is absent, its place being taken by a spreader 1 (Fig. 79) 2½ in. long, ¼ in. wide, $\frac{3}{32}$ in. thick, mounted on trestle trees 2, which likewise support a bow-shaped crosstree 3, 2 in. wide; a square hole 4, ¼ in. square, is provided to take the squared heel of the topgallant mast. The cap 5 is similar to that on the lower mast, and is best cut to shape from boxwood or some strong material ⅛ in. to $\frac{1}{16}$ in.

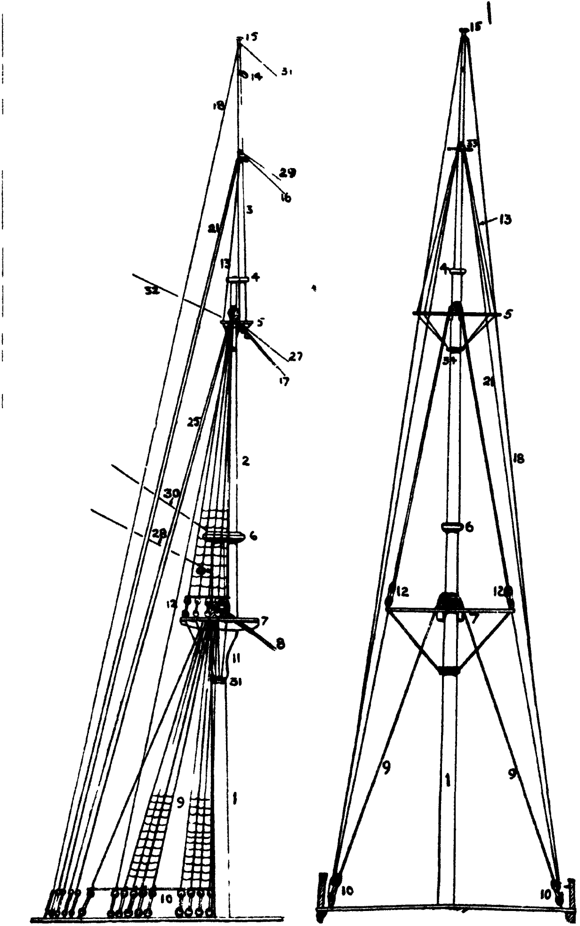


Fig. 80 Fig. 81

Figs. 80 and 81.—Masts and Rigging

thick. It is shaped as shown, and drilled with two holes, one to accommodate the upper mast and one to fit tightly on the lower, to which it is glued and pinned; two little angle-blocks or knees of wood should be glued underneath the tops and crosstrees to further strengthen it. These can be seen at 11. in Fig. 80, which is a side view of the masts, showing the arrangement of the rigging.

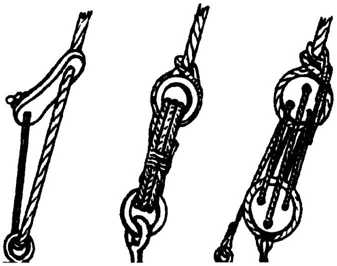


Fig. 82.—Setting up the Rigging

Step all the masts. see that the lower masts fit nicely into the squared holes already cut in the hull to receive them, also that they stand upright. Then proceed with the standing rigging. Put on the lower shrouds 9 first. These are put on in pairs, first one pair to port and then a pair to starboard, forming an eye or loop in the bight of the rope round the mast, and setting them up with deadeyes and a lanyard as shown at 10 (Figs. 80 and 81). This is also shown in greater detail in Fig. 82.

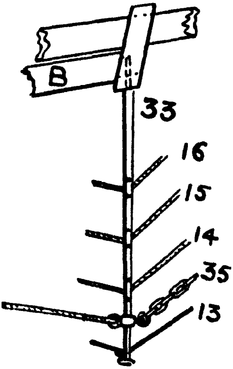
When all the shrouds are in place and set up for the lower mast. the ratlines 9 can be fitted. They are merely thin cord tied to the shrouds. Next set up the topmast shrouds 12 (Figs. 80 and 81) in the same way as those for the lower masts; but in this case it is not possible to use screw-eyes; the cord from the lower deadeye has to be continued downwards through the hole in the top to a band round the mast as shown at 31.

The topgallant shrouds are dealt with in a similar manner. but are set up without deadeyes. For the model it will suffice to draw the cords up tight and make fast. The positions are clearly shown at 13 in Figs. 80 and 81, which also shows the mast truck 15, main royal stay 31. two blocks stropped to the royal pole at 14 to take the main royal lifts (to be described later), main topgallant stay 29. fore topgallant braces and blocks 16. topgallant mast 3, mast caps at 4 and 6. topmast crosstrees 5. main top 7. topmast 2. main mast 1, main royal backstays 18, main topgallant backstays 21. main topmast backstays 25. main topmast stay 27. mizen topgallant stay 30. mizen lower topsail brace and block 28. fore lower topsail braces and blocks 17.

The mainstay 8 is looped round the mast and set up to a strong screw-eye on the deck. The other stays are similarly fitted. Always put the stays on in pairs where possible. and always loop them round the mast in the bight of the rope and secure with a throat seizing or lashing. The topgallant backstays are further secured in place by resting on a crosspin 33 (Fig. 81) which adequately prevents them slipping downwards. Treat all the masts in a similar way and fix all the standing rigging between them as already shown.

The jibboom can now be fitted in place, passing it through the cap, and securing it with a heel block as shown in Fig. 71.

The dolphin striker 33 (Fig. 83) must now be made from brass wire, bossed and drilled for the various stays to reave through. It must also have two eyes fitted near its outer end to take the chain 35 which acts as a martingale and sets up to a band and eye on the jibboom. The fore royal stay 13 reaves through the jibboom end, through the dolphin striker, and sets up to the knight head. The fore top-gallant stay 14 has an eye formed in it as shown; a turn is taken round the jibboom and then seized with



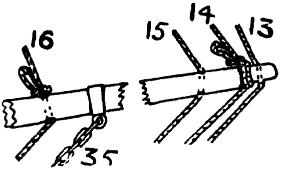


Fig. 83.—Rigging of Bowsprit

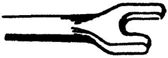


Fig. 84.—Spanker Gaff

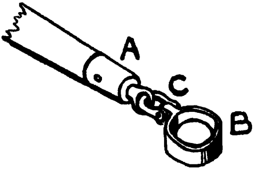


Fig. 85.—Spanker Boom and Gooseneck

thread. It then reaves through the dolphin striker and thus acts as a martingale. 15 is dealt with in the same way as 13, and 16 has an eye formed in the rope as shown. These eyes are needed to take the sails and are a convenience when using the model.

The spanker gaff is shown in Fig. 84. The fork or "gaff jaws" may be formed from the solid or built up from two pieces of mahogany glued and pinned to the gaff. Both methods will be satisfactory; but take care to see that the jaws can pass freely up and down the mizen mast.

The boom is fitted with a brass cap A (Fig. 85) with a screw-eye soldered into the end. A mast band and lug B is then made to fit nice and snug on the mizen mast, while a shackle C connects the two and enables the boom to move in any desired direction.

Details are shown in Fig. 86 that call for a word or two of explanation. They are the purchase tackle (Fig. 86), which consists of a "double" block 4, secured to a rope 5 by turning it round the block and serving the ends as shown. Another, but "single," block 2 is shown stropped with brass wire terminating in a hook, the form in which they are usually sold for model work. This hooks into a screw-eye 1. The lanyard is fixed to the block 2 as shown at 3. reaves through the double block, through the single block, back through the double block, and the free end 6, made fast as requisite..

Sails.—When the masts and standing rigging are all completed, the sails and running rigging (Fig. 87) should be put in hand.

The best material for the work is the striped sailcloth sold by model supply shops.

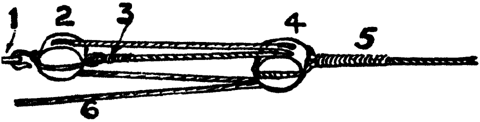


Fig. 86.—Purchase Tackle

As the stripes on the sailcloth are meant to represent the separate "cloths" used on real sails, it is important to cut the material so that the stripes run the proper way. This can be seen by reference to Figs. 88, 89. and 90. which show respectively a jib, topsail and spanker.

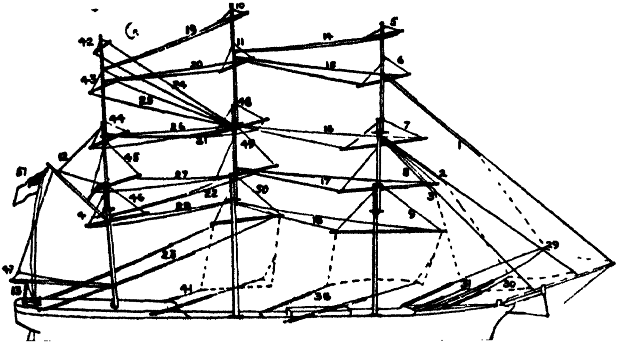


Fig. 87.—Sails and Standing Rigging

First of all it is necessary to cut a paper pattern for each sail to the exact size of the finished sail. The dimensions of each sail are set out in the table below.

The letters refer to those marked on the sail illustrations, and the figures are the lengths in inches along the side of the sail, measured on the cloth, and exclusive of ropes, eyes or fittings.

For example, the length of the side B of the jib in Fig. 88 is 12½ in., the length of side J is 5½ in., and of K 7½ in.

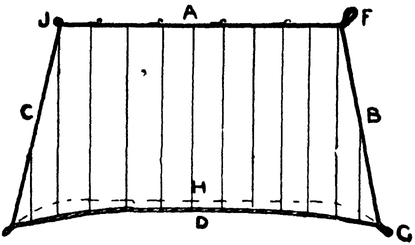


Fig. 89.—A Square Sail

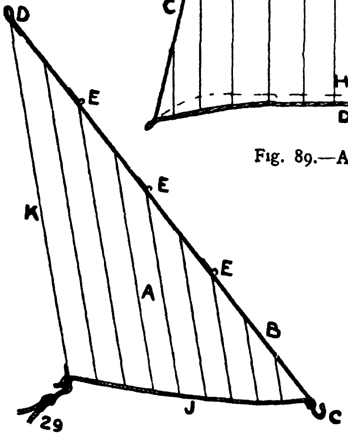


Fig. 88.—Jib Sail

It should be noted that Fig. 89 gives the shape of the topsails, the "courses" or three lower sails, the foresail, mainsail and crossjack being shaped as shown by the dotted line H.

The names of the various parts of the sails are as follows : Head—the top of a sail A (Figs. 89 and 90). Leech—the side B and C. Luff—the weather leech or side first touched by the wind B (Fig. 90) and B (Fig. 88). Foot—the bottom or lower edge D (Figs. 89 and 90) and J (Fig. 88). Clews—the two lower corners of a square sail G (Fig. 89); also the after lower corner of a fore and aft sail 29 (Fig. 88); peek—the upper aftermost corner of a spanker or trysail D (Fig. 88) and E (Fig. 90). Tack the foremost lower corner of a fore and aft sail E E (Fig. 90) and C (Fig. 88).

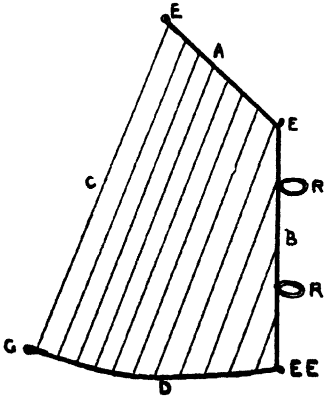


Fig. 90.—The Spanker

Having cut out the sail patterns, lay them all out on the cloth to the best advantage and cut out the sails. Then hem the edges other than the selvedges, or bind them with fine prussian binding ¼ in. wide. The binding is probably the easier of the two methods.

The next thing is to sew on the bolt ropes, as the ropes that are sewn round the edges of the sails are called. Taking the head sails (Fig. 88) first, commence at the peak D by forming an eye in the rope; continue along the luff B to the tack C, where another eye is to be turned in the rope. Follow along the foot of

DIMENSIONS OF SAILS (Fig 88)

	B	K	J.
	in.	*in*	*in*
Flying jib	13	9	5
Jib	12½	9	5¼
Fore topmast staysail	10½	7½	5½

DIMENSIONS OF SQUARE SAILS (Fig 89)

	A	B and C	D
	in	*in*	*in*
Fore royal	4¼	2¾	5¼
Fore topgallant	5½	4¼	7¾
Fore upper topsail	8	3¼	9½
Fore lower topsail	9¾	3	11¾
Foresail	12	4¾	14
Main royal	4¾	3	5¾
Main topgallant	6	4¼	8¼
Main upper topsail	8½	3¼	10
Main lower topsail	10¼	3	12¼
Mainsail	12½	5¼	14½
Mizen royal	3¾	2½	5
Mizen topgallant	5¼	3½	7¾
Mizen upper topsail	8	3	9½
Mizen lower topsail	9¾	2½	12
Crossjack	12¼	5	13½

the sail and form another eye as shown at 29. The eye of the hook C is simply opened, inserted through the rope eye and then closed up. The special hooks E will have to be made from thin brass wire, bent to shape as shown in detail at F. The shank that is sewn to the sail will be better if flattened on the under side, as it will then get a better grip on the rope. They are secured by sewing them on, and their use is to keep the sail in place on the stay S; but when the sail has to be removed it can be freed from the stay, as these hooks E and F just allow the stay to slip through the opening.

The halliard H terminates in a special hook shaped as shown at G. The hook part is hooked into the upper rope eye D, while the small eye formed on the upper part of the hook surrounds the stay S. These hooks can readily be bent to shape from thin brass wire with a pair of small round-nose pliers, and they serve two purposes—to support and hoist the sail, and guide it up the stay S. These hooks and the detachable eye fittings E and F are freely used on the sails wherever requisite.

Spanker (Fig. 90). A 5¾ in.; B 4¾ in.; C 8¼ in.; D 7½ in.

The topsails and courses (Fig. 89) are made and roped in a similar manner; but the eyes on the head of the sails are of unequal size. Those on the right, as shown at F, are to be large enough to slip over the end of their respective yards. The eye at J is to take a small hook, as are those at the lower corners G. Four detachable eyes are to be fitted to the head of the square sails as at A.

The spanker can be made in the same way; the rope eyes at the corners can all be quite small.

Running Rigging.—The next thing is to hoist the yards and set up the "running" rigging—that is, all the ropes and gear needed to control the sails.

Only the ropes that are absolutely necessary are shown in Fig. 87, and are as follows: The flying jib halliard 1 terminates in a guided hook G (Fig. 88), is taken up to a stropped block on the fore topgallant mast, and down to the deck, where it is made fast to the fife rail or belaying-pin rack. The fore topmast staysail halliard 2 is similarly arranged, but passes through a stropped block under the fore crosstrees; the jib halliard 3 is similar. The fore lower corners of all these sails hook into the loops already formed in their respective stays.

The sheets consist of a "pendant" or length of rope with a throat seizing in the bight, and provided with a small brass hook, as shown at 29 in Figs. 87 and 88. Each end of the pendant is then spliced to a single block, and the sheet rove through the block. One end is made fast to the deck, the other to the fife rail or pin rack. The flying jib sheet is shown at 29 in Fig. 87, the two ends being fitted one on each side of the forecastle. The fore topmast staysail sheets 30 and the jib sheets 31 are similarly fitted.

All square sails mounted on a yard require as a minimum the following ropes: Halliards H (Fig. 91), a parrel or truss K, sheets D, braces G, one at each yardarm, lifts F, one at each yardarm, a jackstay N to secure the sail, and an outhaul L. All the yards are to be fitted in the same way, except the royal yards, which, being at the top, have nothing above them, and the sheets D are omitted.

Taking the fore upper topsail yard as an example, proceed to rig the yard as shown in Fig. 91, noting that on the left of the illustration the yard is shown broken away and the sail R slacked off. First mount the bands C ½ in. in from the ends, each band having two eye-bolts as shown. Take care to keep them opposite one another, one pair to the upper side of the yard and one pair to the back. Fix the jackstay N on the upper part of the yard, stretching it between the two eyes C as shown. This can preferably be made of thin brass wire. Lash it to the yard in four places, as shown at O, but leaving a space between

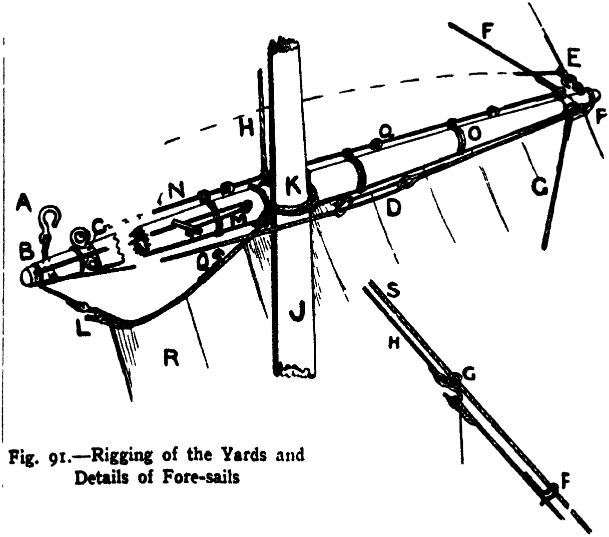


Fig. 91.—Rigging of the Yards and Details of Fore-sails

the jackstay and the yard by working the lashing round the stay and yard and sewing the space between them with cotton or silk. The detachable eye fittings, shown at Q, on the head of the sail hook over the jackstay and keep the sail in place. At one end of the yard drill a small hole diagonally to take the outhaul L as shown at B ; also at both ends drill other similar holes for the sheets D to pass through. Fit the screw-eye and bowsie on the outhaul, take the single end through the hole B and splice the hook L into it. Fit up the sheets as follows through the single hole at P ; pass a cord and form an eye in one end of it, as shown at D, and splice a hook E into the other end. Lead another cord through the hole at the other end of the yardarm, through one hole in the bowsie, through the eye in the pendant (or first cord), through the other eye in the bowsie, and make it fast with a knot. The other end is spliced into a hook A. The parrel K is simply a short length of cord doubled and passed round the mast J, opened out and round the yard and seized together as shown at K. The halliard H is given a turn round the yard and secured with a seizing. The lifts F and braces G are spliced into their respective eye-bolts.

To hoist and set the sails, proceed as follows : Hoist the yard with the aid of the halliard H and lifts F. Take the sail that sets below the yard and slip the long eye F (Fig. 91) over the yardarm P (Fig. 91). hook the detachable eyes Q on to the jackstay N, and hook the outhaul L into the small eye J (Fig. 91) on the head of the sail and haul it taut with the bowsie M. The clews of the sail that sets above the yard are attached to the hooks A and E of the sheets D (Fig. 91) and hauled taut. All the square sails are dealt with in the same way.

It only remains to run the lifts, halliards and braces to their proper places. The halliards should be dealt with first, and the royal halliards taken to a stropped block near the masthead and down to the deck.

The lifts are dealt with as follows: Each leads through a double-stropped block on the mast at the positions stated. The fore royal 5 to near the masthead, the fore topgallant 6 to the head of the topgallant mast, or one-third down from the mast-truck, the fore upper topsail lift 7 to the fore topmast cap, the fore lower topsail lift 8 to just under the fore topmast crosstrees, the fore yard lift 9 to the foremast head cap.

The lifts on the "main" yards are similarly arranged, as are those on the mizen and as shown in Fig. 91. Main royal 10, main topgallant 11, main upper topsail 48, main lower topsail 49, mainsail 50, mizen royal lift 42, mizen topgallant 43, mizen upper topsail 44, mizen lower topsail 45 and crossjack 46.

The braces are arranged as follows: Each pair of braces leads through a double block stropped to the mast at the positions stated, and then down to the deck where they are belayed. The fore royal braces

14 go to the main topgallant masthead, fore topgallant braces 15 to just below the fore royal brace block, fore upper topsail braces 16 to main topmast crosstrees, fore lower topsail braces 17 to main masthead cap, fore yard braces 18 to main top, main royal braces 19 to head of mizen topgallant mast, main topgallant braces 20 to just below the main royal brace block, main upper topsail braces 21 to the mizen topmast crosstrees, main lower topsail braces 22 to mizen top, mizen royal braces 24 to main topmast crosstrees, mizen topgallant braces 25 to main topmast crosstrees, mizen upper topsail braces 26 to main topmast crosstrees, mizen lower topsail braces 27 to main mast head cap, and crossjack braces to main top.

The main braces 23 are rigged with a pendant at each yardarm, one end spliced into the eye on the yardarm, and a single block spliced into the other end. A sheet is rove through the block, one end being made fast to the hull side, and the other led through a hole in the ship's side and to the belaying-pin rack amidships. The fore sheets 36, and main sheets 41, are similarly arranged.

It only remains to attach the boom and gaff to the spanker and mizen mast. The spanker is laced direct to the gaff, the eyes E (Fig. 90) on the head of the sail being used to accommodate a lashing, as is the eye at E E to lash the sail to the boom. The foot of the sail is not lashed to the boom.

CHAPTER X

Building a Model Racing Motor Boat: The Hull

THE construction of a model racing motor boat presents many features of interest. The model when completed is entirely self-contained, and possesses all the qualifications for a good afternoon's amusement in running the same.

The motive power is steam, as this form of driving plant gives the utmost force for a given weight, and at the same time is most suitable and adaptable to amateur construction. The primary source of power is the blow-lamp, and this has received careful attention, so that the utmost amount of heat is obtained from the petrol used. A flash boiler, consisting of a duplex coil of seamless steel tubing enclosed in a suitable casing, is employed for the generation of the steam. This in turn energises a double-acting vertical high-speed engine, which, coupled to the propeller shaft, drives a two-bladed propeller. The engine is in the forward portion of the vessel immediately in front of the boiler.

The general appearance of the finished boat is shown by Fig. 92. The general character of the hull of this model is shown by Figs. 93 and 94, which give the sheer plan, body plan, and half-breadth plan respectively.

Mould Box.—To proceed with the construction of the model. the first operation will be the construction of the mould box as described in earlier chapters. For this purpose the one-third full-size mould plan (Fig. 95) may be used.

The mould plan originates from a common base line A B, whereas the body plan has a variable depth due to the sheer or longitudinal curvature of the boat. This method of utilising a common base line as in the mould plan is of advantage, as by adopting it the sheer, or gunwale, is indicated by the notches N.

The easiest way of marking out the timber for the construction of the mould is to re-draw Fig. 95 full size. The drawing is to be cut in half along the vertical centre line C L only. There is no need to cut out the other shapes. A centre line should be marked on a piece of board of suitable width, arranging this line to run the way of the grain. The base line A B should next be marked off, and from this the position of the L.W.L., 4⅛ in. up, is to be marked. Now lay the half of the mould drawing in position on the board, arranging it so that C L (centre line) on the paper coincides with the centre line on the board, and the base line A B on the paper coincides with the base line on the board. The L.W.L. lines should now agree also. Next secure the drawing in this position with two drawing-pins or a weight, and

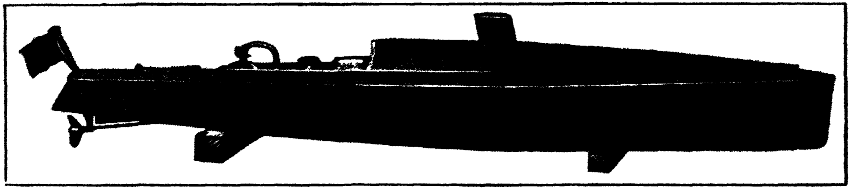
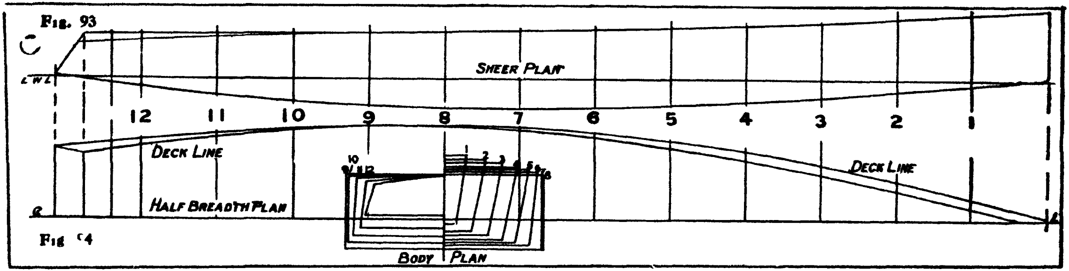


Fig 92 —View of Model Racing Boat



Figs 93 and 94 —Hull and Body Lines

with a sharp awl or pricker stab through the lines. Then remove the paper, turn it upside down, and again place it in a similar position to the first, but on the opposite side of the centre line on the board, and stab through the same holes. On removing the paper again, a series of marks will be noticed in the timber, and with a ruler and pencil mark lines through

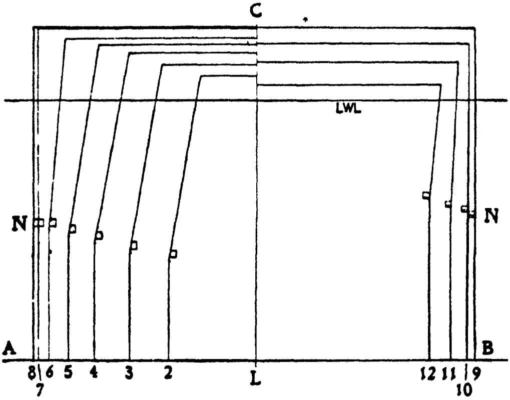


Fig. 95.—Mould Plan for Model Boat

these points, the result, which is readily accomplished, being a full-size drawing of the particular section or mould. Carefully cut along these lines, finishing the same accurately with a plane and chisel, finally cutting out the notches N, and one mould is ready for use. Make all the others in a similar manner, and when they are ready proceed to construct the complete mould box by cutting a groove at each section for the reception of the same. Screw each of the moulds in position with two screws about 1½ in. long from the under-side of the bar, and the building of the hull can be proceeded with.

Planking.—Before proceeding further it must be decided whether to build the hull of wood or of metal, reference being made to earlier pages for detailed instructions.

If a wooden hull is decided upon, the timber to be used may be either best dry yellow pine, mahogany, or cedar, according to which is most readily obtainable. A piece about 7 ft. long and 9 in. wide will be sufficient, and when planed up on both sides should measure ⅜ in. thick. Having obtained the material, which must be free from knots or splits, and planed it up true and flat on both sides, cut off one piece measuring 3 ft. 4 in. long and 8½ in. wide for the bottom of the boat, and two pieces 3 ft. 4 in. long and 4 in. wide for the two sides. Next take a piece of pine $\frac{5}{16}$ in. thick when planed up, and cut out the

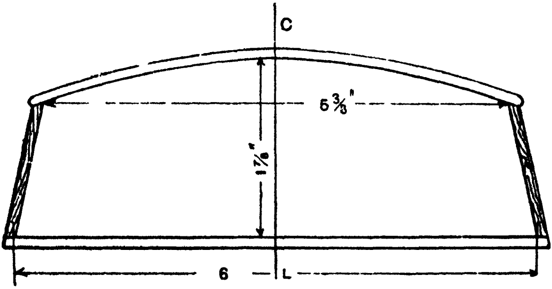


Fig. 96.—Transom

transom ; this is shown half full size by Fig. 96. The transom is the end piece which completes the stern of the vessel, and is shown at T in Fig. 97. Also prepare a block of mahogany or pine and shaped as shown in Fig. 98, in accordance with the dimensions there given. This is for the stem piece or nose of the boat. Now mark a centre line down the length of the piece selected for the bottom of the boat, and lay it on the top of the moulds, tying it with string in position

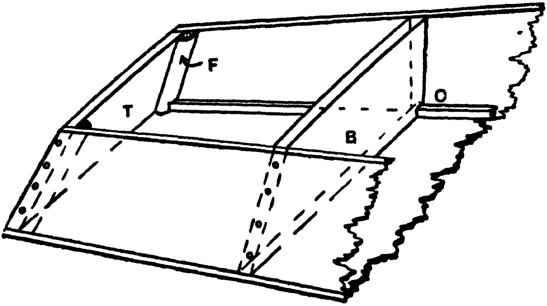


Fig. 97.—The Stern

with its centre line coinciding with the centre line of the mould box. Carefully turn the whole upside down, and mark with a lead pencil the extremities of the moulds on the bottom plank. Remove this plank, and mark out the outside shape of the bottom of the boat by marking off a line $\frac{3}{16}$ in. away from the marks already taken, to allow for the thickness of the sides of the hull, and leaving a little for cleaning up. Next cut two thin splines or battens $\frac{1}{8}$ in. square and 3 ft. long, and lay them in the notches N (Fig. 95).

They are readily secured by simply tying the ends with a thin string.

The two pieces of timber selected for the sides of the hull are now laid in position in the moulds. They are bent and secured in position temporarily with a few panel pins driven through the hull sides into the moulds, aided by tying the ends into position. Mark off the true heights from the moulds, and run a pencil round the under-side (as the model stands) of the batten; then remove the sides, and cut the pieces to the correct shape as indicated by the marks.

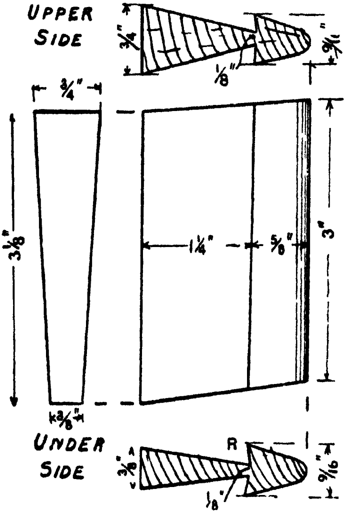


Fig. 98.—The Stem Piece

Now replace the two sides in their proper positions, and fit the stem piece (Fig. 98) into place, cutting the forward ends of the side planks until they fit properly into the rebate R cut in the nose piece, checking the length and position by trying the bottom piece in position and measuring from the forward mould to the stem.

The transom (Fig. 96) is to be fitted in a similar manner, and when this has been done cut some wooden clamps from any ordinary timber about ⅜ in. thick; about a dozen are required for the sides of the hull, and one special one for the transom ends. Half a dozen similar clamps are required to secure the batten or inwale that has been fitted in the notches. Fig. 99 shows the method of clamping two pieces together, C and C^1 showing clamps in position. The clamps are cut with slightly tapered jaws, and are merely driven into position. This method will be found a great aid in fitting up the work. Holes for five countersunk brass screws must be drilled in readiness to secure the sides to the stem and to the transom. Mark the sides, ends, stem, and transom, so that all can be reassembled readily and easily. Then remove the components, and having put a piece of newspaper over the edges of each mould at the corners, fit the two sides to the transom and stem pieces by gluing and screwing the same together.

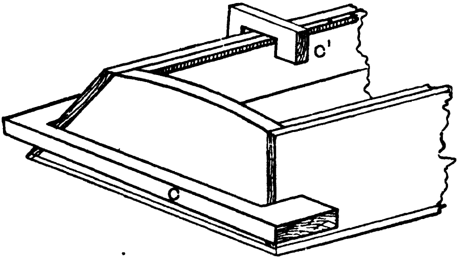


Fig. 99.—Method of applying Clamps

Fit the stem piece first, and then glue the battens or inwales and fit these, securing them with the little clamps. After having bent the sides into position, finally secure the transom by gluing and screwing securely with brass screws. It is best to leave the work now until the glue has set hard and dry. Then take the bottom plank, and, having heated it, glue the same, and secure in position by means of the clamps, securing the bottom to the sides with short panel pins or very fine brass screws.

After the hull has set thoroughly hard (and it is advisable to let the work stand for twenty-four hours), remove the clamps and clean up the edges of the hull on the outside with a sharp plane.

The outside of the hull should now receive a coat of grey paint or a coat of varnish if it is desired to leave the outside in its natural colour.

Bulkheads.—While the paint on the hull is drying prepare the " fillets " and cross bulkheads. Two of the latter are required, and they should be cut to fit sections Nos. 1 and 12. They should be ¼ in. thick, and preferably of mahogany. The fillets are prepared from some ¼-in. square pine, with one corner planed away; about 2 ft. of this should be prepared. As soon as the paint is dry the hull may be removed from the mould box by unscrewing the moulds. Remove section No. 6 by gently pushing the same towards section 7, until it can be lifted out of the hull. Remove No. 5 in the same way, and also remove Nos. 8, 9, 11, and 12; but these latter must be pushed towards the centre mould No. 7. Sections 1, 2, and 4 may also be removed; but Nos. 3, 7, and 10 should be left in position until the bulkheads and the two "boiler bearers" are fitted.

The two bulkheads may be glued and screwed into position straight away. The forward one is to be fitted 3 in. from the stem, and the after one 6⅜ in. from the stern, as at B (Fig. 97.) When these two bulkheads are in place, the moulds Nos. 3 and 10 may be removed.

The two boiler bearers must be cut from mahogany ¼ in. thick, Fig. 100 showing what is required. These bearers are cut away as much as possible to reduce the weight, while the boiler B will ultimately rest on a pad of asbestos secured to the curved portion A. These two bearers should be spaced 6 in. apart, the forward one being 1 ft. 4 in. from the bow or stem.

The bearers are similarly glued and screwed into position, both through the sides and the bottom of the hull. The fillets are simply glued and pinned into the vertical corners of the transom as at F (Fig. 97), and to the corners of the cross bulkheads; but are not necessary for the boiler bearers.

The top edge of the hull sides, adjacent to the inwales, will probably require slight touching up with a plane to make the sides and inwales true. A similar fillet or chime is fitted at the bilges or bottom corner of the hull to strengthen the same, as at C (Fig. 97).

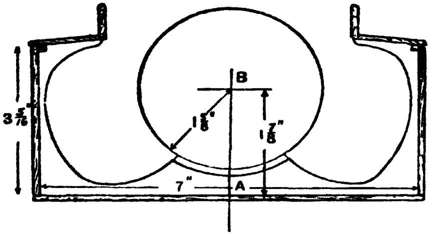


Fig 100.—Section Showing Boiler on Bearers

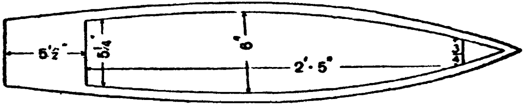


Fig 101.—Plan of Deck

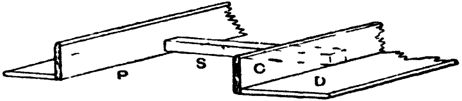


Fig. 102.—Fixing the Coaming

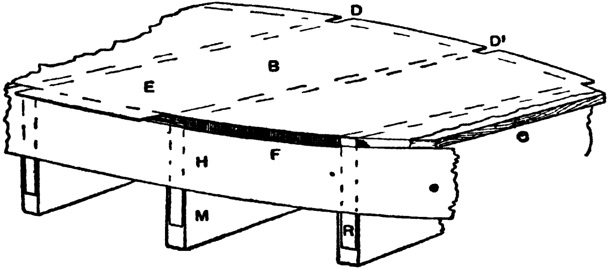


Fig. 104.—Preparing the Bottom Plate

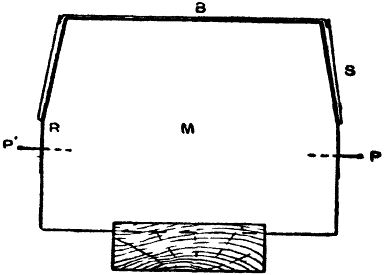


Fig 103.—Making the Metal Hull

Deck.—The deck is made in the same way as the bottom, and should be cut so that the edges project slightly, just sufficient to allow of the edge being neatly rounded off to give a finish to the boat. The dimensions for the cut-away portion are indicated in Fig. 101. It should be mentioned that the deck looks best if cut from ⅛-in. thick yellow pine, neatly ruled with a pencil with lines ¼ in. apart to represent planks. A mahogany coaming must be prepared, and should measure 1 in. in width and be slightly under ⅛ in. in thickness. This should be arranged with a rounded top, and is secured to the deck before the same is finally fitted to the hull, by gluing and strutting out the sides with short pieces of ¼-in. square stuff S, fine panel pins P being driven into the edge of the deck D through the coaming C as shown in Fig. 102. It must be noted that the coaming fits on top of the deck, forward of the bulkhead at section No. 1.

The interior of the hull should be painted, and the deck may be secured in place with fine brass screws or panel pins, and varnished.

Metal Hull.—Those readers who prefer a metal hull must first prepare a mould box; but the notches N (Fig. 95) need not be cut. The edge of the deck (which is the under-side of the notch as the mould stands) needs to be marked clearly with a lead pencil. Having obtained the mould box, cut a sufficient number of strips of thin brass ¼ in. wide and bare

$\frac{1}{16}$ in. thick, and fit one of these over each mould, clean, and "tin" the same in readiness for soldering. These ribs or pieces of metal should project about 1½ in. below the deck line on the mould, and a small hole should be drilled through each one to enable a pin or screw to pass through into the mould to secure the rib in place. This is shown in Fig. 103, where M is one of the wood moulds, R the metal rib, and P and P^1 the panel pins holding the rib temporarily to the moulds, the outer shell of the hull being indicated at S and B.

After a rib has been fitted in a similar manner to each mould, the sides S and bottom B of the hull should be prepared, and for the purpose a piece of sheet-zinc about No. 20 gauge thick may be employed. Cut out to shape two pieces, one for each side, so that they accurately fit in place on the mould, where they should be secured by soldering to the ribs. It will suffice at the present time to merely "tack" each rib at the top and bottom with solder, as this process can more readily be finished when the hull is removed from the mould box.

The piece of metal prepared for the bottom should now be cut to shape; but this piece must be cut ¼ in. wider each side to allow for the same being flanged down. Having so far prepared the bottom plate, lay it in place, and mark it so that it may be replaced in the same position. Then mark off accurately the position of each rib, and cut away the part left for the lip or flange, so that it fits snugly round the rib. Then with the aid of a piece of wood about ¼ in. thick, temporarily screwed to the moulds and cut to the true size of the bottom of the boat (that is, the piece of wood should fit closely against the edge of the zinc hull sides), lay the zinc bottom plate on this and carefully flange it over. When this has been accomplished, remove the wooden template and replace the metal plate; but this time the lipped edges will be fitted inside the hull sides, and close against the same. Now carefully solder the bottom piece in its place, taking care to see that the lip fits closely against the hull sides before it is soldered. Fig. 104 shows diagrammatically these processes, B being the bottom plate, C the wooden template secured temporarily in place, D and D¹ parts cut away to fit round the ribs, F a finished flange or lip, and E the plate before flanging.

The stem should be finished by cutting a brass plate about $\frac{1}{32}$ in. thick, and bending the same into shape to form a nose piece as shown in Fig. 105. The dimensions will be similar to those for the wooden hull. This brass piece is simply cut from the sheet, and bent to shape. The tab pieces as at T and T¹ being bent up and ultimately soldered to the insides of the deck and the bottom plate, the sides in addition are securely soldered, thus making a strong and rigid stem.

The stern is finished in much the same way as on the wooden hull, a piece of the zinc being cut according to the sizes given in Fig. 97.

The ribs are then all securely soldered, and afterwards the upper portions are bent over to form a support for the deck, as shown at E (Fig. 106). The deck D is then cut to shape in much the same way as for the wooden model, and is soldered to the supports. These are then bent upwards as at F to form a support for the coaming C.

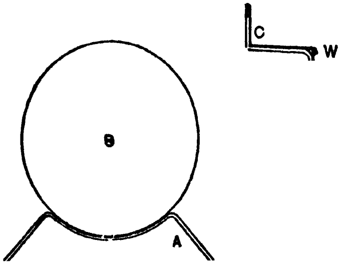


Fig. 106.—Section of Stern of Hull

Fig 105.—Nose-piece for Stern

A bulkhead cut from zinc should be soldered in place at sections Nos. 1 and 12.

The edge of the deck is very neatly finished by soldering a brass wire, either circular or half-round in section, along the joint of the deck with the hull side, and for this purpose the deck should project slightly to form a housing for the wire, which should ultimately be finished off and filed up neatly, as shown at W (Fig. 106).

CHAPTER XI

A Model Racing Motor Boat: The Boiler

FIGS. 107 and 108 show the disposition of the various parts, and it will be seen that the boiler B occupies a prominent place. The engine is situated forward at E, and the blow-lamp is, of course, aft of the boiler. The boiler feed pump F, driven by gearing G from the propeller shaft, supplies water to the boiler when the engine is running; but to start up, a separate hand pump H is employed. This pump is placed in a small reservoir, from which it derives its supply. The lubricating oil is drawn from the circular reservoir, and forced by the pump O into the valve chest on the engine.

Steering is effected by the rudder R controlled by the tiller T, the power from the engine being transmitted by the shaft S, through the stern tube N, to the propeller P, a bracket J steadying and supporting the outer end of the stern tube. A spray hood or shield K prevents the machinery being damaged by water and spray, and the funnel L disposes of the products of combustion.

Boiler Casing.—The boiler, being such an important factor in the model, its construction will now be

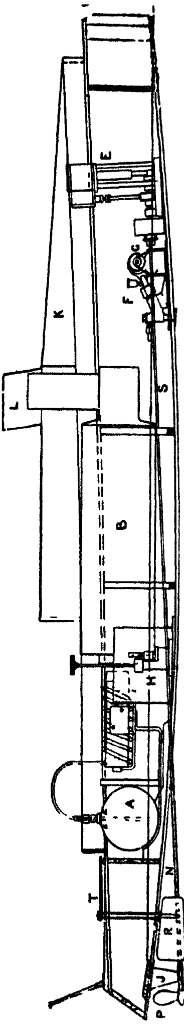
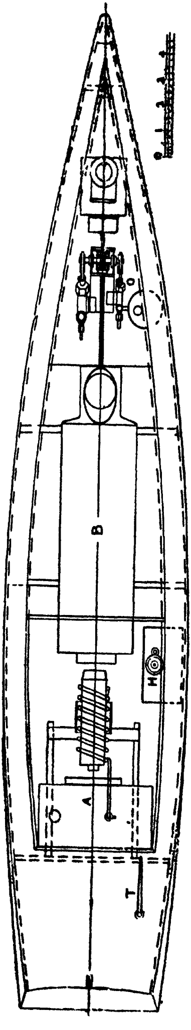


Fig. 107.



Figs. 107 and 108.—Disposition of Various Parts of Model Racing Motor Boat

proceeded with, and reference to Fig. 109 will show that it consists of a circular casing with spun brass ends and a tubular uptake.

For the outer casing a piece of thin brass tube 9 in. long and $3\frac{1}{4}$ in. in diameter will be required. This tube should be as light as it is possible to obtain; or, if it is preferred, the casing may be bent into shape from a sheet of Russian iron, and the seam riveted together. The two end caps A and B (Fig. 110) should be spun from thin sheet brass or copper, one being merely a retaining cap to cover the asbestos lagging, the other being spun up, as shown at B, to form a smokebox. If any difficulty is experienced in making these ends, they can be purchased. The ends are spun so that they need driving tightly into place, and will need no further fixing except perhaps for a set-screw or two put through the lip into the casing. This would be advisable in any case if the sheet-metal casing is used.

Funnel.—The funnel or uptake F consists of a piece of thin brass tubing 1⅜ in. in diameter and 6 in. long. This is fitted in place on the smokebox by cutting a hole through the spinning, flanging out the end of the funnel at each side, and riveting the same securely in place, as indicated in Fig. 110 at D and also in Fig. 111.

Tubes.—The actual boiler consists of a length of about 20 ft. of seamless steel tubing T $\frac{3}{16}$ in. in diameter. This should first of all be softened by heating to a dull red colour, and allowing it to cool slowly. The tube is readily heated over an ordinary gas ring or the domestic gas stove. To bend up the tube, obtain a piece of iron bar or gas barrel 1½ in. in diameter, and secure this by any suitable means. Then take a 10-ft. length of the steel tube, and bend it round the bar, securing one end of the tube to the bench while the other part of the tube is being bent.

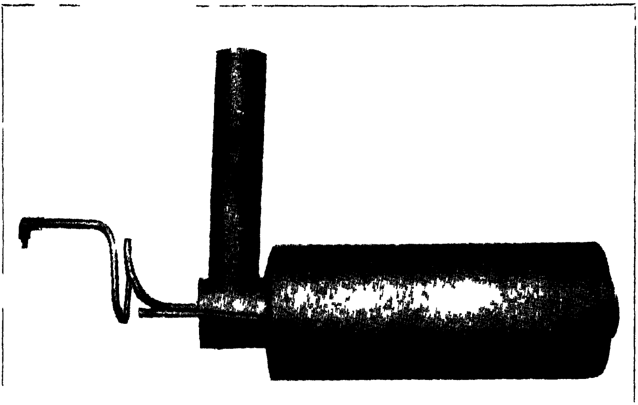


Fig 109.—Finished Boiler

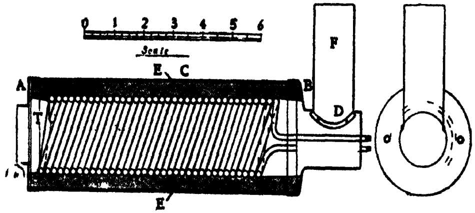


Fig 110

Fig 111

Figs. 110 and 111.—Section and Elevation of Boiler

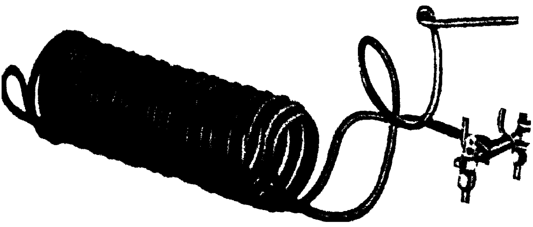


Fig 112—Boiler Coil, showing Check Valve Fitted

Bend both lengths of the steel tube in the same way, and bend two similar ends at right angles and cut them off short. Screw the ends, and cut and drill out a piece of steel bar $\frac{3}{8}$ in. in diameter and $\frac{3}{4}$ in. long, and screw this tightly on to the tube. One piece of the tube should be screwed, so that this union piece can screw right on to it. The end of the other tube is butted against the first tube, and the union part is then partly unscrewed from the first tube, so that it secures both tubes. This cannot be carried out, however, until both coils have been screwed into each other, making practically a solid tube of coiled metal as shown in Fig. 112. The remaining two ends are employed, respectively, to take the feed water supply and to lead the steam to the engine. Two holes should be drilled through the smokebox end-cap to allow these to pass through in the manner shown in Fig. 109. Some thin asbestos cardboard should be cut to the same length as the casing, wetted, and then wound tightly round the boiler coil, as at E (Fig. 110). The whole mass is then driven into the casing tube. The two end-caps should be fixed in place, and the boiler is practically finished.

To secure the boiler in its place in the boat, a holding-down strap A (Fig. 113) will be required. This consists of a strip of aluminium $\frac{3}{4}$ in. wide and 9 in. long, bent to fit round the boiler, in the manner shown in the illustration, the feet F being bent at right angles; a $\frac{1}{4}$ in. hole is drilled through the same to allow the holding-down bolt B (Fig. 114) to pass through. The holding-down bolt is made from a piece of $\frac{3}{16}$-in. diameter steel rod screwed to take a standard hexagonal nut. This stud should be riveted to a brass plate C, $\frac{1}{32}$ in. thick, which is drilled with four holes, to allow of its being screwed to the bottom

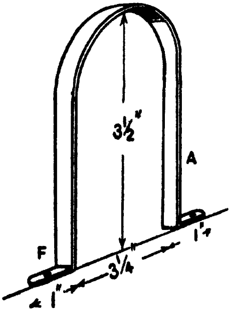


Fig. 113.—Holding-down Strap for Boiler

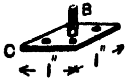


Fig. 114.—Holding-down Bolt

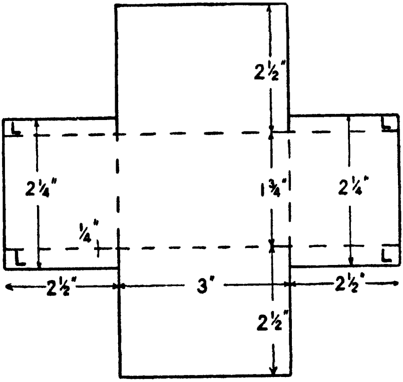


Fig. 115—Development of Feed Tank

of the wood hull, or riveted to the metal hull. Two of these plates will be required; but only one holding-down strap is needed.

The next piece of apparatus to take in hand is the feed pump and tank. For this purpose take a piece of thin sheet brass 8 in. long and 6¾ in. wide, and then cut it out to the shape and sizes given in Fig. 115. Bend up the four lips L at right angles to the plate. Then with the aid of a block of hard wood cut to the correct inside size of the tank, bend up the four sides, and solder the whole securely together; also put in a couple of small copper rivets at each corner as additional security.

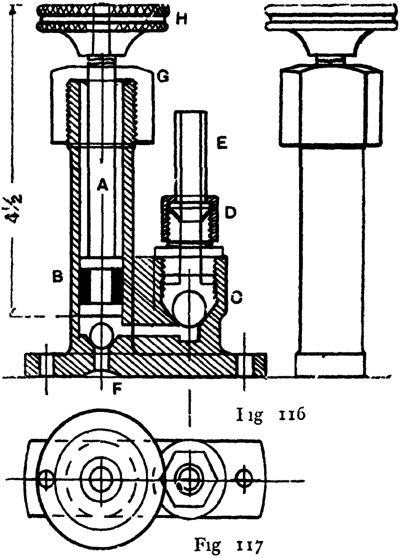


Fig 116

Fig 117

Figs. 116 and 117.—Details of Pump

Hand Pump.—The hand pump can be made from solid metal, or patterns may be made and castings obtained; but the finished article may be so readily purchased at quite a small cost, and so eminently suitable for the purpose, that the worker is strongly advised to adopt this course. However, those who prefer to make their own pump will find full details and dimensions in Figs. 116 and 117. The barrel and body of the pump B is made from a brass casting. The ram A is made from the solid metal, with a neat circular handle H fitted to the upper end. The inlet is at F, the inlet valve consisting of a conical seating

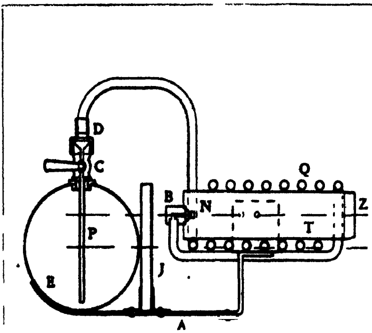


Fig. 118.—Section of Blowlamp

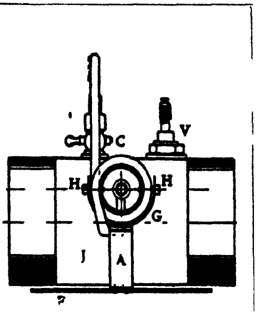


Fig. 120.—Front Elevation of Blowlamp

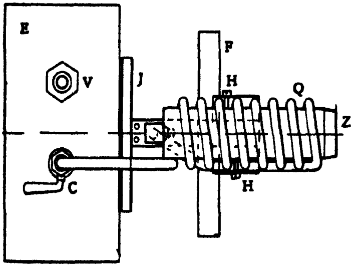


Fig. 119.—Plan of Blowlamp

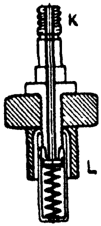


Fig. 122.—Details of Air Valve

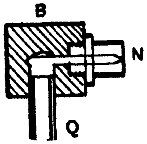


Fig. 121.—Details of Nipple and Block

and a bronze ball. The delivery valve C is of similar type, and from the union E a copper pipe is led to the check valve on the inlet pipe of the boiler coil. As a separate check valve is required for the supply from the engine feed pump, a **T**-piece must be fitted to the end of the boiler inlet tube ; this **T**-piece should be so fitted that it is just clear of the end of the smoke-box. Two check valves with regulating cocks are fitted one on each side of the **T**, and here again the worker is recommended to purchase these ready made, as the construction of these small fittings occupies a lot of time, and the articles are quite cheap. The check valves should be of ample size, and all joints must be very tightly screwed, and very strongly made.

The boiler, and hand-feed tank with the pump, may if desired be fixed in place in the hull ; but it is recommended that they be assembled on a stout board until satisfactory steam trials have been carried out.

Blow-Lamp.—Next in order comes the construction of the blow-lamp, and this requires some little care to ensure success. The general arrangement of it should be grasped from Figs. 118 to 120.

The principle of the burner is very simple, neither is there any difficulty in its operation. The container E (Fig. 118) must first be two-thirds filled with good petrol ; and with the aid of a cycle pump, the air is pumped up to a pressure of about 15 lb. per square inch. On opening the plug cock C some of the petrol is forced through the pipe P, and the vaporising coils Q round the burner tube T, and so to the nipple N. From here it issues in a fine spray, and by so doing it induces a current of air to flow through the burner tube, where the petrol spray and air mixes thoroughly finally issuing from the nozzle Z in the form of a gas, which when ignited should burn with a blue flame, about 6 in. or 7 in. in length, accompanied by a roaring noise.

To start the burner, the vaporising coils Q (Figs. 118 and 119) must be heated to a " black heat " before turning on the petrol, as it is imperative for the success of the burner that the petrol is heated sufficiently to vaporise before leaving the nipple.

The construction of this petrol blow-lamp does not call for any particular workmanship ; but every care must be exercised to see that all joints are truly petrol-tight, even under air pressure.

The container E (Fig. 118) can most conveniently be made from a piece of light brass tube 5 in. long and 2½ in. in diameter, with ends spun from $\frac{1}{32}$ in. thick copper plate, or turned up from castings, and pinned and soldered or brazed on ; but before doing so, a bush for the outlet pipe or regulating cock C and a bush for the inlet or air valve V must be brazed or soldered in place. In view of the pressure generated in the container, and the naturally high temperature of the flame, it is undoubtedly best to have all the joints brazed. If the ends are only soft soldered. a $\frac{1}{8}$-in. diameter brass stay, with nuts inside and out at each end, must be fitted through the centre of the container.

The vaporising pipe Q is made of $\frac{3}{16}$-in. outside diameter solid-drawn copper tube, and to shape it properly it is simply coiled round a mandrel of hard wood. To render the tube quite soft for bending, it should be heated to a dull-red heat and plunged in cold water. One end of the coil is screwed and brazed into the union D on the regulating cock C (Fig. 118). The other end is screwed and brazed into a solid block of brass B, with a right-angle passage drilled in the same, and into which is screwed the nipple N, as shown in Fig. 121. These nipples can be bought for a few pence, and are similar to those used for "Primus" burners. The pipe P (Fig. 118) is $\frac{5}{32}$ in. in diameter, and should be soldered to the cock C, and run to the bottom of the tank. A roll of fine copper gauze should be inserted in the tube at D to prevent backfires.

The burner tube T consists of a piece of brass tube 3$\frac{3}{4}$ in. long by 1 in. in diameter, and with the front end beaded down to form a nozzle as shown. The nipple is arranged so that it is just in the centre at the end of the burner tube, as shown in Fig. 120. To keep the burner and container in place, a piece of strip brass A (Fig. 118) $\frac{1}{2}$ in. wide and $\frac{1}{32}$ in. thick is bent and screwed and soldered to the container E. and projects forwards to form a support for the burner, a cross piece F (Figs. 119 and 120) being riveted in place to keep the burner steady when in the boat. A sheet-iron clip G (Fig. 120) is riveted to the support A, and secures the burner tube by means of the two screws H. A flame guard J, consisting of two sheets of lagging iron with a ¼-in. thickness of asbestos between them, is to be riveted in place as shown, and prevents the heat of the burner from damaging the container.

Fig. 123.—Finished Blowlamp with Guard

The regulating valve C may be made from rod metal; but as it can readily be purchased for a few pence, it is not worth while making. This also applies to the air valve V.

CHAPTER XII

A Model Racing Motor Boat : The Engine

THERE are numerous types of engines more or less suitable for model racing-boat work ; but after careful consideration the one shown by Fig. 124 has been selected. The reasons for this choice are that the type and disposition of the engine lends itself readily to the purpose, the cylinder dimensions (bore $\frac{5}{8}$ in., stroke $\frac{5}{8}$ in.) are just what is required, and the engine can be bought either finished ready for use, or the rough castings only may be purchased. The engine may be purchased complete with screws, studs, nuts, and all the machining work done. But to obtain the best results, one or two details will require altering from the stock article. The cylinder could be greatly improved if it were made of cast-iron in place of the gunmetal supplied.

The illustrations give the leading and necessary dimensions of all the important parts.

A general idea of the completed engine can readily be obtained from the photograph and the sectional drawing (Fig. 125). The cylinder is shown at B, and is shaded to render this important part more easily seen. A is the top cover and P the bottom

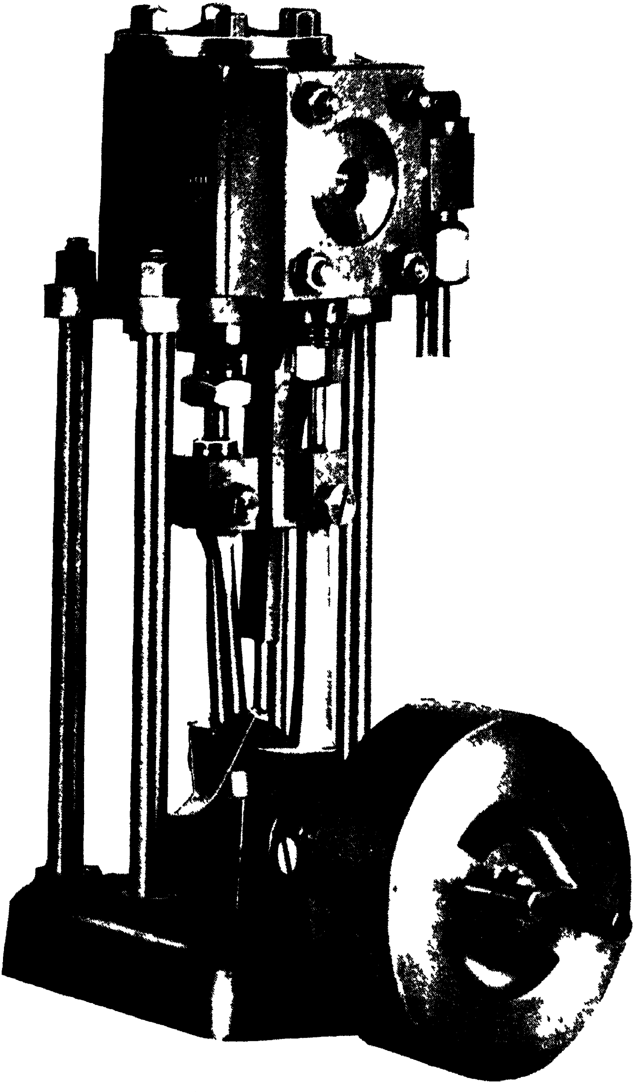


Fig 124.—The Power Unit

cover. C is the steam chest in which the slide valve, controlled by the valve spindle and nut X, operates.

The valve is actuated by the eccentric and rod L, which is jointed at K to the valve spindle; a packing gland and nut D keep the spindle tight. The piston W is screwed to the piston rod, which is secured at its other end to the crosshead J, and by means of the connecting rod and crank pin Y the crank-shaft G is operated. Four turned-steel columns Q support the bottom cover and cylinder and a packing gland and nut E is provided to keep the piston rod tight. A massive flywheel R provided with two driving studs S is fitted and secured by a "grub screw." Two small oil pipes *b* and *c*, provide for the lubrication of the main bearings, their supply being obtained from an "oil box" (Figs. 126 to 128).

The bedplate N (Fig. 125) is a soft-iron casting, and work on the model should be begun by filing up the under-side of the same fairly flat. Next mark off and drill the holes for the four standards Q. These holes should be drilled as shown at P in Fig. 129, and tapped out $\frac{1}{8}$-in. Whitworth, to suit the standards. The two main bearings (Fig. 130) should next be finished up. Drill the holes for the crank-shaft $\frac{3}{16}$ in. in diameter, and then put a short length of shafting through the holes, bringing the two bearings together; by this means the under-sides can be filed up flat and true. Clean up the castings neatly to shape, and drill the holes $\frac{3}{32}$ in. in diameter for the holding-down bolts. Mark off the position of the holding-down bolts on the bedplate, and drill and tap the same $\frac{3}{32}$ in. Whitworth. Carefully true up the surface of the bedplate before fitting these bearings and take great care with the marking out, otherwise trouble and binding will inevitably follow.

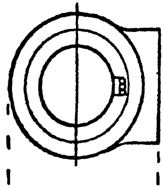


Fig. 126

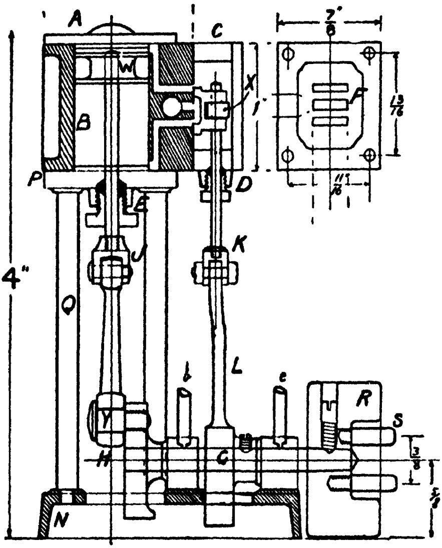


Fig 125

Figs. 125 and 126.—Section of Engine

The crank-shaft G (Fig. 131) is made from a length of $\frac{3}{16}$-in. mild- or silver-steel rod, well polished, and it should turn freely but without any shake in the bearings. The crank disc H is simply drilled for a driving fit on the crank-shaft, and then driven securely in place and riveted. The disc can then be turned up true when in place, and the hole for the crank-pin Y (Fig. 125) drilled and tapped $\frac{5}{32}$ in. The crank-pin can be turned up from the solid mild-steel bar, but is supplied ready for use in the machined set of parts. Two short lengths of $\frac{3}{32}$-in. diameter brass pipe should be secured in place in the bearings as shown at *b* and *c* (Fig. 125).

Turn up the flywheel and fit the two steel studs S (Figs. 125 and 132), and note that the crank-shaft is merely turned very slightly taper, and the flywheel driven on tightly and secured with a grub screw.

The eccentric sheave M (Figs. 133 and 134) should next be taken in hand, and this will probably prove a difficult task. There are many ways of tackling this job; but one of the best is to chuck the sheave by the boss and turn up the outer face, drilling through the $\frac{3}{16}$-in. hole for the crank-shaft. Then put a short length of brass rod about $\frac{1}{2}$ in. in diameter in the chuck, turn up the end true and flat and mark the centre, and at a distance of $\frac{3}{32}$ in. from the centre put a centre-punch mark, and scribe a circle bare $\frac{3}{16}$ in. in diameter. Place the eccentric sheave on the end of this piece of metal, with the hole for the crank-shaft over the scribed circle and solder the same in place, with the centre of the sheave over the centre of the brass piece. The outer rim of the sheave may now be turned up to $\frac{5}{8}$-in. diameter, and the central groove turned; face up the end of the boss, and the sheave is ready for use. The strap is chucked on the faceplate or firmly screwed on a wooden plug, held in the three-jaw chuck, and should be a nice easy fit

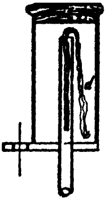


Fig 127

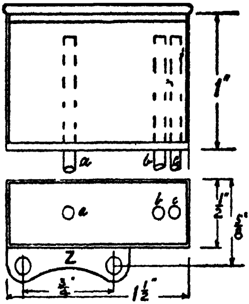


Fig. 128

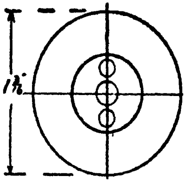


Fig. 132

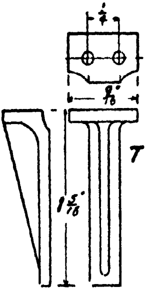


Fig. 136

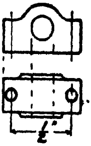


Fig. 130

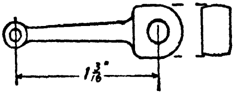


Fig. 135

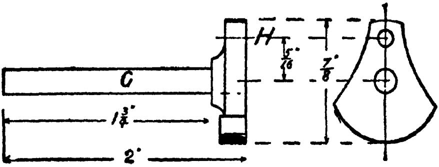
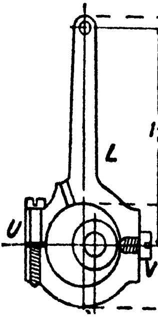


Fig 131



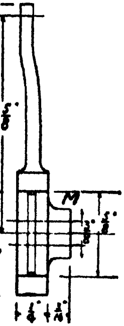


Fig. 133 Fig. 134

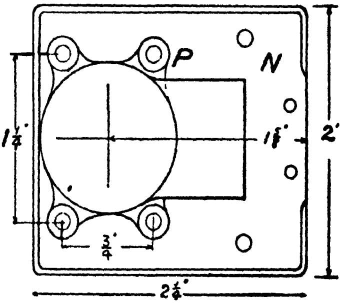


Fig. 129

Figs. 127 to 136.—Details of Engine Construction on the sheave, but not loose. Drill an oil hole as shown and also fit the small retaining screw V (Fig. 133), so that the point of this screw just runs in the groove, thus keeping the strap in place. To allow for wear, the strap is split on one side, and secured with a set-screw $\frac{3}{32}$ in. in diameter as at U (Fig. 133).

The connecting-rod (Fig. 135) is a gunmetal casting, and merely requires cleaning up and drilling at each end as shown, the small end being drilled $\frac{3}{32}$ in. and the big end $\frac{3}{16}$ in. to suit the crank-pin.

The bottom cover must be finished next: this is also a gunmetal casting. It is best machined by marking off and drilling the four holes P (Fig. 129). Next screw a piece of hard wood on to the faceplate, and turn the face perfectly flat. Scribe a circle the same diameter as the diagonal distance between the holes N, and mark their position on this line. Screw the casting on to the wooden faceplate, and turn up the top of the cover. Turn the spigot that fits into the cylinder $\frac{5}{8}$ in. in diameter, drill the centre hole for the piston rod, and scribe the circle for the cylinder retaining screw holes before removing the casting. Reverse it and face up the gland, and drill out and screw the same $\frac{1}{4}$ in. in diameter. Remember to place a washer under the cover when it is reversed to allow it to lay flat on the faceplate. Making this part is a neat piece of work, and great care must be taken with it. The main gland nut is similar to the valve spindle gland D (Fig. 125).

Next finish off the guide bar T (Fig. 136). This is a gunmetal casting, and requires careful filing to sizes; it is simply screwed into place. The cross-head (Fig. 137) should slide freely on the guide bar.

The cylinder may now be taken in hand, and it is needless to say that it requires the greatest care if a successful result is expected. Presuming a self-centering chuck is available, grasp the work firmly, setting the casting so that it runs as true as possible. Next turn up the face and edge as much as possible, and then with a sharp boring tool turn out the interior, passing the tool right through each time. Take a good cut at the start to get under the scale, and run the lathe at a good speed. With care the result should be a nice, smooth bore. Reverse the casting, and turn up the other end true and flat and to dimensions in Fig. 138. The valve face F (Fig. 125) may be filed up flat, or may be turned by mounting the cylinder on an angle plate on the faceplate.

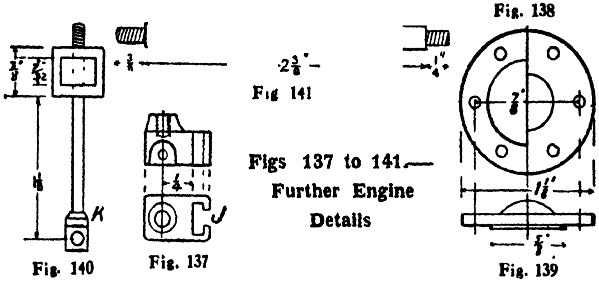


Fig. 140 Fig. 137 Fig 141 Fig. 138 Fig. 139

Figs 137 to 141.—Further Engine Details

Mark off the position of the steam and exhaust ports (Fig. 125). This latter should be $\frac{5}{64}$ in. wide and $\frac{5}{16}$ in. long, and the bars or spaces between the ports $\frac{7}{16}$ in. wide and $\frac{5}{16}$ in. long. The ports are formed by drilling a row of small holes, joining the top port with other holes at right angles drilled to break into the top of the cylinder. The bottom port communicates with the bottom of the cylinder, the exhaust connecting with an outlet hole screwed to take the exhaust pipe, the steam being admitted through a hole drilled in the cover of the valve chest. The valve chest and cover are easily filed to size, but take care to drill the hole for the valve rod and gland at D at right angles and quite square. Turn and fit the top cover (Figs. 138 and 139), and fix it with $\frac{3}{32}$ in. screws.

The piston W (Fig. 125) is drilled and fitted to the piston-rod, and afterwards turned to fit. The crosshead (Fig. 137) requires careful fitting ; take care to fit the part J to slide on the guide bar T (Fig. 136) nicely, and to drill the hole for the connecting-rod pin carefully at right angles. Finish the valve spindle (see Fig. 140) in a similar manner, taking care to make a good job of the valve, which should be made from mild steel. The nut X (Fig. 125) is drilled and tapped $\frac{3}{32}$-in. Whitworth, and the valve rod is screwed to suit ; by this means the valve may readily be adjusted to its proper position.

The lubricating arrangements may now be taken in hand. First construct the oil-box (Figs. 126, 127, and 128) from thin sheet brass. The case is arranged to slip on two of the vertical standards Q (Fig. 141), and is secured by the holding-down nuts. The lid for the oil-box can readily be made of hard wood, and the pipes *a*, *b*, and *c* are simply $\frac{3}{32}$-in. diameter brass pipe, soldered in place as shown, and bent when in position, so that pipe *a* comes immediately at the top of the guide bar T (Fig. 136). By this means oil can drip on to the guide bar, and thoroughly lubricate both this and the crosshead. The pipes *b* and *c* respectively lubricate the main bearings, and may be connected to the short pipes on the bearings by means of a sleeve of brass tube slipped in place to hold both ends in position. A few strands of wick lead the oil to these pipes as shown at *d* (Fig. 126).

The valve chest should be drilled and tapped to take a standard No. 1 check valve for the forced-lubrication supply. and take care this fitting is cleaned off flush inside the valve chest.

The engine is now ready for steam trials, and as the hand-pump has already been made, fit a union for $\frac{3}{16}$-in. pipe into the valve-chest cover, and connect the same to the steam pipe from the boiler. Thoroughly oil the engine at all moving parts. The cylinder and glands should be tightly packed with asbestos string, and the valve set to give a good lead, by setting the eccentric about 30° in advance of the crank.

CHAPTER XIII

A Model Racing Boat : Boiler-feed Arrangements

Feed Pumps.—Figs. 107 and 108 show a single feed pump, but it will be found advantageous to fit two feed pumps for the one shown, and to still further reduce the speed of the oil pump by introducing a " two-to-one " gear. Those readers who prefer to adopt the original arrangement can easily do so by merely omitting the extra pump and the pair of gear wheels.

Reference to Figs. 142 and 143 in comparison with Figs. 107 and 108 will give a good idea of the complete pumping arrangements. The two feed pumps H and J (Fig. 143) are driven by eccentrics F and G on a cross shaft E. This is driven from an extension of the engine shaft, and a 15 to 1 reduction worm gear is employed to give the necessary slow movement. The oil pump L is driven by 2 to 1 spur gears K, the oil pump being driven at half the speed of the water pumps, and it is operated by a short connecting rod M driven from a stud P attached to the larger of the two gear wheels as shown in Fig. 144.

The two water pumps are operated alternately by setting the eccentrics at 180°, or opposite each other, so that when one pump is forcing, the other is on the suction stroke. The two outlets R^1 and R^2 are connected by a Y-shape pipe as shown in Fig. 145 at D, two pieces of $\frac{3}{16}$ in. pipe being bent and brazed on

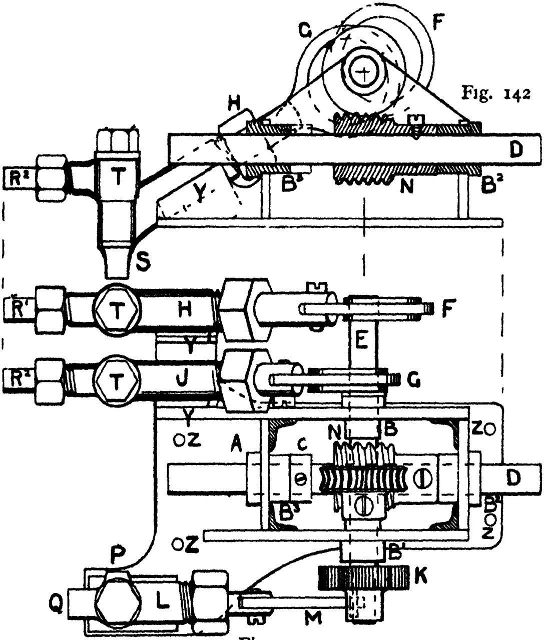


Fig. 142

Fig. 143

Figs. 142 and 143.—Complete Pump Arrangement

to the T-piece, A, which is in turn fitted with an elbow E, connects the check valve C, which has already been fixed to the inlet pipe on the boiler. The union and cock at B is employed as a by-pass, and a pipe is led from B to the side of the vessel.

To construct the mechanism, a casting may be made, or the gear-box may be constructed from sheet brass $\frac{1}{16}$ in. thick, and as this latter course will probably commend itself to most readers, the accompanying illustrations give the necessary particulars for this method of construction. The baseplate A (Fig. 146) is to be cut to shape and hammered up flat and true. Two side plates (Fig. 147) should then be cut and drilled at B for the bushes, noting that only one plate is required with the extension Y, the other plate being cut along the line C P. Two end plates (Fig. 148) should be cut and drilled as shown. These are then fitted together to the baseplate by means of small angle brass, riveted and soldered into the corners as well as to the base. Four bushes should now be turned to provide a bearing for the shafts, and it will be noted that they are of different lengths as regards the shoulder portion. Fig. 149 shows the bush B, one of which will be required. Two bushes as Fig. 150 may be turned, and one as in Fig. 151. These are all uniform as regards the diameter, being $\frac{3}{8}$ in. in diameter at the shoulder portion and $\frac{1}{2}$ in. in diameter across the flange or lip portion. All of them are drilled out $\frac{1}{4}$ in. in diameter to suit the shafts E and D (Fig. 143). The worm and worm wheels shown can be purchased, but will require drilling out to suit the shafts.

Having obtained the gears, they should be fitted in position as shown, a small collar C (Fig. 143) being

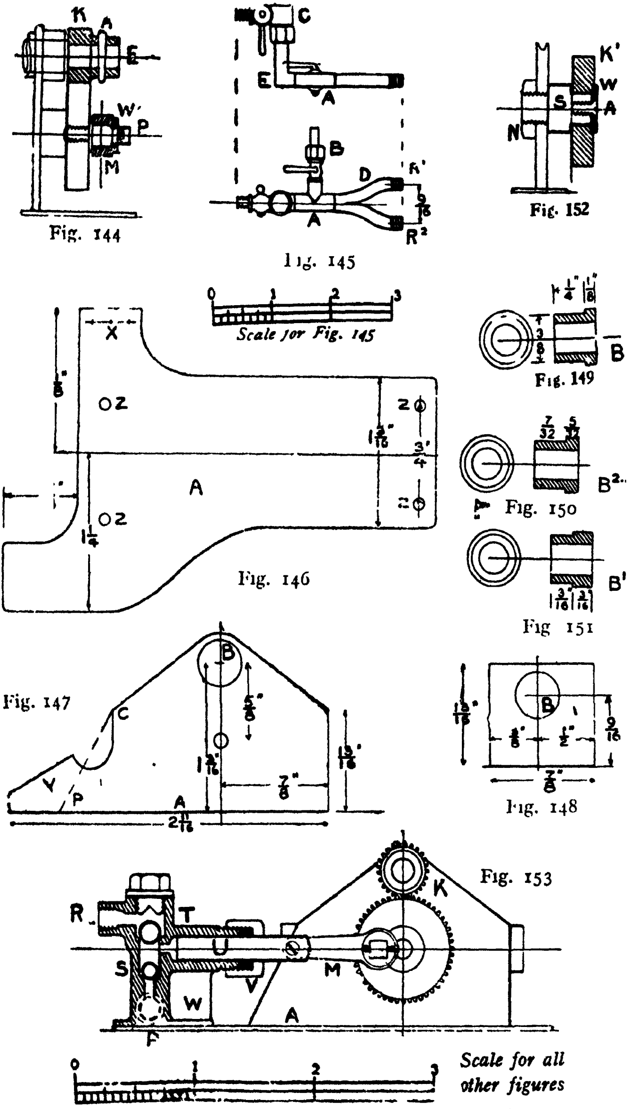


Fig. 144

Fig. 145

Scale for Fig. 145

Fig. 152

Fig. 149

Fig. 146

Fig. 150

Fig. 151

Fig. 147

Fig. 148

Fig. 153

Scale for all other figures

Figs. 144 to 153.—Details of Engine Pump, etc.

fitted to keep the shaft D in position. The gears may need slightly trueing up when in position to ensure them running smoothly; and as an additional aid to this end the bushes might be turned slightly eccentric, so that they may be twisted into their holes to provide an adjustment before being soldered into place; but this eccentricity is not shown in the illustrations. It will be best to now obtain the two spur gears K, and these may readily be purchased at most model dealers. The smaller pinion is secured to the shaft E by a taper pin A as shown in Fig. 144, and it must be noted that the shaft requires to be shouldered down to $\frac{3}{16}$-in. diameter to suit this gear wheel. A stud S (Fig. 152) must now be turned from $\frac{3}{8}$-in. diameter mild steel rod, and the wheel K′ bored out $\frac{1}{4}$ in. in diameter to suit, a slight recess being turned in the face to accommodate the washer W. This is secured in place by a $\frac{1}{8}$-in. countersunk screw A. The stud is tapped $\frac{1}{4}$ in. in diameter into the plate (Fig. 147), and secured by a nut N as in Fig. 152. Another and smaller steel stud P (Fig. 144) must be turned and fitted to the wheel K to accommodate the connecting rod M for the operation of the oil pump as in Fig. 153. This stud should be turned $\frac{3}{16}$ in. in diameter to suit the connecting rod M, the outer portion of the stud at P being filed square and a washer W with a square hole being fitted to the same and secured with a split pin as shown. The stud should be provided with a slight shoulder $\frac{1}{32}$ in. thick, to give clearance between the connecting rod and the face of the gear wheel, and ultimately reducing to ⅛ in..in diameter, and drilled and tapped into the wheel K′.

Oil Pump.—The oil pump is a standard fitting as supplied by most model dealers, and as they can be purchased for a very low price, this method is advocated, as there is a good deal of work required in the pump. Should any reader wish to construct the pump, full details are shown in Fig. 153, where it will be noted the ram U is $\frac{3}{16}$ in. in diameter and 1⅛ in. long, the inlet ball valve being ⅛ in. in diameter and the delivery valve $\frac{3}{16}$ in. in diameter. The connecting rod M may be cut from a piece of ⅛-in. brass and filed up to shape, the base of the pump being secured to the bedplate by two $\frac{3}{32}$-in. screws and nuts. The two water-pumps H and J (Fig. 143) are the standard No. 2 size pump with eccentric, which are readily obtainable, or may be built up as desired.

The arrangement of parts is the same as the horizontal pattern, except that the pump barrel enters the body T at an angle of practically 30°. The pump J and eccentric G may be fitted without difficulty; but to fit the pump H an angle piece Y (Fig. 154) must be cut and fitted to the baseplate on the projection X (Fig. 146). The two eccentrics are readily fitted to the shaft by means of the set-screw usually provided on these fittings. To complete the gear it is only necessary to turn a pair of drivers (Fig. 155).

One of these should be provided with two steel studs P ⅛ in. in diameter, the other driver being provided with slots as shown at S. It should be noted that the fitting S should be on the end D of the shaft (Fig. 143), and the slot should be filed to accommodate the driving pins already fitted to the finished engine.

The piping arrangements may be seen from Fig. 156, the oil pump taking its supply from a tank P, and delivering the oil through the pipe Q and check valve R to the engine A. The water from the two pumps H and J is delivered through the fork pipe R^1 and R^2, passing the by-pass B to the check valve C, the starting being accomplished by pumping water by the hand pump from the tank at H to the other check valve D, which is connected with the T-piece T to the pipe E leading to the boiler. From here the steam pipe S leads directly to the valve chest on the engine.

The oil tank is readily made as shown in Figs. 157 and 158, by cutting a length of 1½-in. diameter thin brass tube and 2½ in. long, and soldering a disc 2 in. in diameter at the bottom, enclosing the top with a smaller disc, and fitting a filling plug F. This should be brought well to one side as shown, so as to be clear of the coaming when fitted into position. A union at P facilitates the fitting of the supply pipe, which should be led from this fitting to the intake P (Figs. 143 and 153) on the pump, where a similar union should be fitted.

The water supply to the feed pumps being obtained from the pond, it will be necessary to make a small scoop as shown in Fig. 159. This consists of a flat box B with a piece of ⅜-in. diameter brass tube projecting downwards as at A. This is open at the end, and should be filed off at an angle as shown,

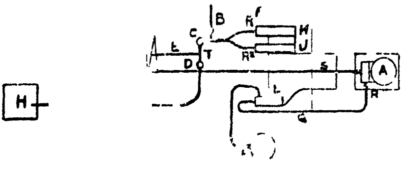


Fig. 156

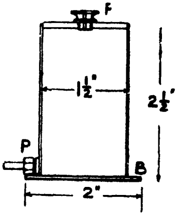


Fig. 157

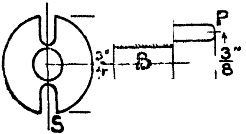


Fig. 155

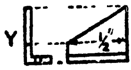


Fig. 154

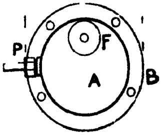


Fig. 158

Figs. 154 to 159.—Further Engine Details

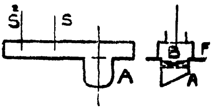


Fig. 159

and the bore of the pipe should be filled with copper gauze B. The two feed pumps are soldered directly into this supply pipe as at S and S², and arranged so that the scoop A is on the centre line of the boat. The flange at F provides for screwing the feed pipe to the bottom of the boat. The dimensions for this piece must be taken from the model.

CHAPTER XIV

A Model Racing Motor Boat : Finishing

Of the work that remains to be executed for the completion of the model, the propeller and shaft undoubtedly are the most important, and reference must therefore be made to Fig. 160, which shows the shaft, stern tube, and bracket assembled in position.

Propeller Shaft.—The propeller shaft may be made of $\frac{1}{8}$-in. diameter mild-steel rod, and is 2 ft. 3 in. long. The stern tube is made in two portions ; the outer portion A is 11$\frac{1}{4}$ in. long and $\frac{3}{16}$ in. outside diameter, and consists of a thin brass tube, and should be of such a thickness that the propeller shaft will just revolve easily without undue friction.

The inner portion D of the stern tube is 1 ft. 5$\frac{1}{4}$ in. long and $\frac{1}{4}$ in. outside diameter, and its thickness should be such that this tube will slip tightly on to the outside of the first tube for a length of 3 in., where it will be soldered into position. The inner end of the stern tube when fitted in the boat is to be fitted with a small bush as shown in Fig. 161 at B. By this means the friction of the propeller shaft is reduced, and greater speed is therefore obtained. A

Fig. 164.—Palm Piece for Stern Tube

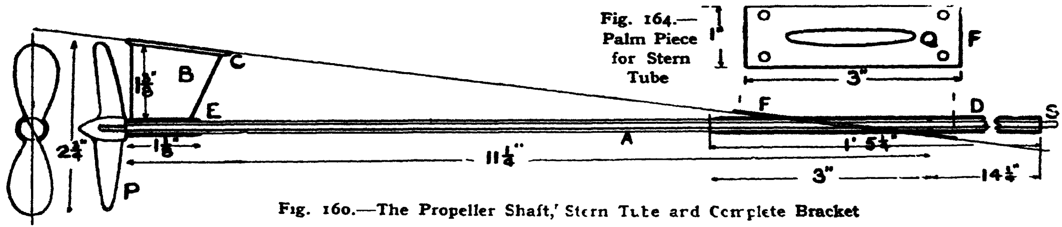


Fig. 160.—The Propeller Shaft, Stern Tube and Complete Bracket

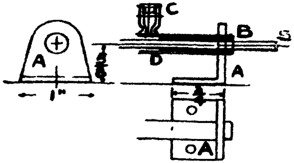


Fig. 161.—Inboard Supporting Bracket

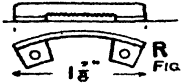


Fig. 166.—Tiller Rack

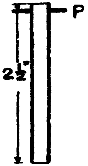


Fig. 167.—Rudder Tube

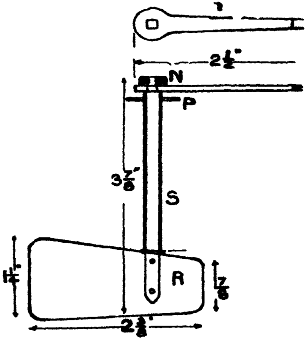
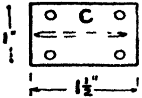


Fig. 165.—Rudder and Tiller



Figs. 162 and 163.—Outboard Supporting Bracket

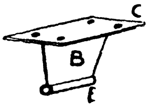


Fig. 163

bracket as in Figs. 162 and 163 must be made to support the outer end of the shaft. This may readily be constructed by cutting a brass bracket B, and brazing a plate C to the top of the same as shown.

To the bottom of the bracket should be brazed a brass tube E ¼ in. in diameter, with a bore of $\frac{3}{16}$ in. to accommodate the outer end of the stern tube. Four holes are to be drilled through the plate, so that the bracket may be screwed to the under-side of the hull; and it should be noted that a thickening piece of wood about ¼ in. thick should be secured to the inside of the hull where the bracket is screwed into position, to strengthen the hull, as shown at J in Fig. 107.

A flat brass plate F (Fig. 164) must be prepared to screw to the hull where the shaft passes through the same. This is simply a rectangular plate with a long oval hole Q in the centre, through which the stern tube is soldered when fixed into position.

To fit the shaft, mark the centre line along the hull, and mark the position of the bracket. Then mark the position of the centre line of the propeller shaft at the point where it cuts the line of the bottom of the hull and drill a ⅛-in. hole through the hull at this point. Then with a long drill passed through the tube on the bracket, carefully drill out the hole through the bottom of the hull. Finish carefully with a file, trying the shaft from time to time until it is fitted in its correct position and correct angle.

A small angle bracket A (Fig. 161) must be cut and bent to shape to secure to the inside of the hull to support the inner end of the propeller shaft and stern tube. This should then be fitted into position, taking care not to strain the shaft in any way, noting carefully that the propeller shaft will turn freely.

Fig. 168.—Diagram Showing Roof Angle of Propeller Blades

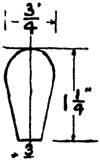


Fig. 169.—Propeller Blade

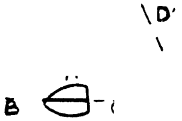


Fig. 171.—Formation of the Propeller Blades.

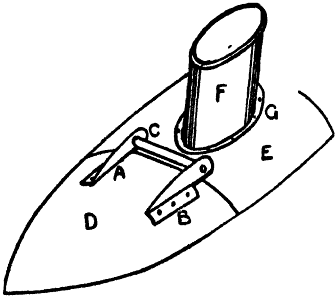


Fig. 172.—The Spray Hood and Funnel

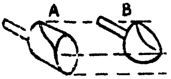


Fig. 170.—Propeller Boss

The hole in the hull round the stern tube may now be filled up with a little red-lead and thread, and the brass plate (Fig. 164) screwed into position on the outside of the hull, afterwards soldering the stern tube to the latter to make it watertight.

A simple screw-lid lubricator may be fitted at the inner end of the stern tube, and if this arrangement is adopted, no packing gland will be required, as the shaft will be above the water level; but the space between the walls of the stern tube and shaft should always be kept filled with oil, otherwise the shaft will speedily rust.

The rudder is shown in Fig. 165. The plate R is simply cut from a piece of aluminium, bare $\frac{7}{16}$ in. thick. The stem S is a length of $\frac{3}{16}$-in. diameter brass rod, slotted at the end to take the rudder blade, and is riveted in place. The upper end is squared and screwed for a nut N, the tiller T being cut from $\frac{3}{16}$-in. brass plate and fitted into position. The extreme end is filed **V**-shape, to engage with the notches cut in the under-side surface of the rack R (Fig. 166). This is simply cut from sheet brass, bent to shape and screwed to the deck.

The rudder stem is fitted through a $\frac{1}{4}$-in. diameter brass tube, with brass disc P $\frac{3}{4}$ in. in diameter soldered to the upper end of the same, and should measure $2\frac{1}{2}$ in. long, as shown in Fig. 167. This passes right through the hull and through the deck. The bottom of the tube where it passes through the hull, if made a tight fit and driven into place with a few twists of thread soaked in red-lead, will be found to be quite watertight. The propeller may be made from a casting, or it may be built up from sheet metal.

Propeller.—As regards the first method, that of using a casting, this should be filed up by hand to correct shape, and must be filed as thin as possible on the edges, and must be finished to the highest possible state of perfection. The propeller cannot be too bright or highly polished.

First of all turn a piece of brass rod to $\frac{3}{8}$-in. diameter, then take a piece of paper and wrap it round the piece of brass, and cut a piece off the paper, so that it exactly fits round the circumference of the brass rod somewhat as shown in Fig. 168, the rectangle A B C D representing the piece of paper. Next mark out another piece of paper as shown in Fig. 168. First draw the straight line C E, mark off a length of 6 in., and erect a perpendicular A C at one end. Make the height of this line equal to the length of paper which exactly fitted to the brass bush. In the case in question this will be very nearly $1\frac{3}{16}$ in. Divide this line in half and mark this point G, and draw a line from G to E, the angle G E C being the correct angle at which to cut the slots in the boss. From the point A draw a line parallel to the angular line G E, the result being that a duplicate piece of paper can be cut having dimensions equal to the first, but with the correct angles shown at which to cut the slots in the boss, in which the two blades are to be fixed.

The two blades are to be cut to the dimensions as shown in Fig. 169. These may be cut from brass about $\frac{1}{32}$ in. thick, and both plates should be exactly the same size. To cut the slot in the boss, paste the specially marked piece of paper round the brass bush, and with a hack saw cut along the angular lines on the paper to a depth of $\frac{3}{32}$ in. The brass bush may then be turned up to its correct shape for the boss. This is shown in Fig. 170 at A. This shows the boss with the slots only cut, and the finished boss at B.

The blades have now to be bent to shape, and this is accomplished by silver soldering them into the slots in the boss, when by looking on top of the blade, when held vertically, the effect will be somewhat as at A in Fig. 171, the blade being flat, but at an angle of B C to the propeller shaft line. The tips or outer ends of the blades must now be grasped with a strong pair of pliers, and twisted until each one assumes an angle as at D E (Fig. 171). It will be seen that the root of the blade, where it is secured to the boss, still retains its original angle B C, this alteration of angle being due to the fact that the peripheral speed at the tip of the blade is much greater than it is at the root, and consequently, to maintain equality of thrust, the angle must vary in proportion.

Finishing.—The propeller is secured to the shaft by screwing and soldering in place, and when this has been fixed, the gears and pumps may be assembled. It will probably be necessary to cut a packing block to suit this gear, so that it can be brought into line with the shaft, and some similar packing will probably be necessary under the engine. Take care to bring the gears, propellers, and engine shafts truly in line and see that the drivers, etc., are all free and turn easily. Secure the oil-box, etc., in place, and complete the pipe connections, when the deck may be screwed in place. Fit up the rudder and screw the tiller in place. Before the model is run a sheet of $\frac{1}{8}$-in. thick asbestos should be screwed or nailed to the floor from the after bulkhead to the pump gear, to protect the hull from the heat of the lamp.

The spray hood and funnel can be made by cutting and bending two pieces of sheet tin to the correct shape. The forward portion, or spray hood D (Fig. 172), is in one piece, and a baseplate is first cut to a triangular shape, $\frac{1}{4}$ in. wider each way than the dimensions of the coaming. To this the curve hood is fitted and soldered, the overlapping $\frac{1}{4}$ in. of the baseplate being flanged over at right angles to fit round the coaming. The after part E is finished in the same way, the baseplates being afterwards cut away to clear the boiler, engine, etc. The funnel F is readily made from a short length of thin brass tube flanged and riveted in place as at G. If the spray hood is hinged as shown at A, it will be found very convenient, as it facilitates access to the engine, pumps, etc., and this result is easily achieved by cutting two arms A and B and riveting in place. A tube G is secured to the hood E by a wrapper and riveting, a plain brass pin forming the hinge.

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